AERONAUTICAL ENGINEERING REVIEW

OCTOBER 1948

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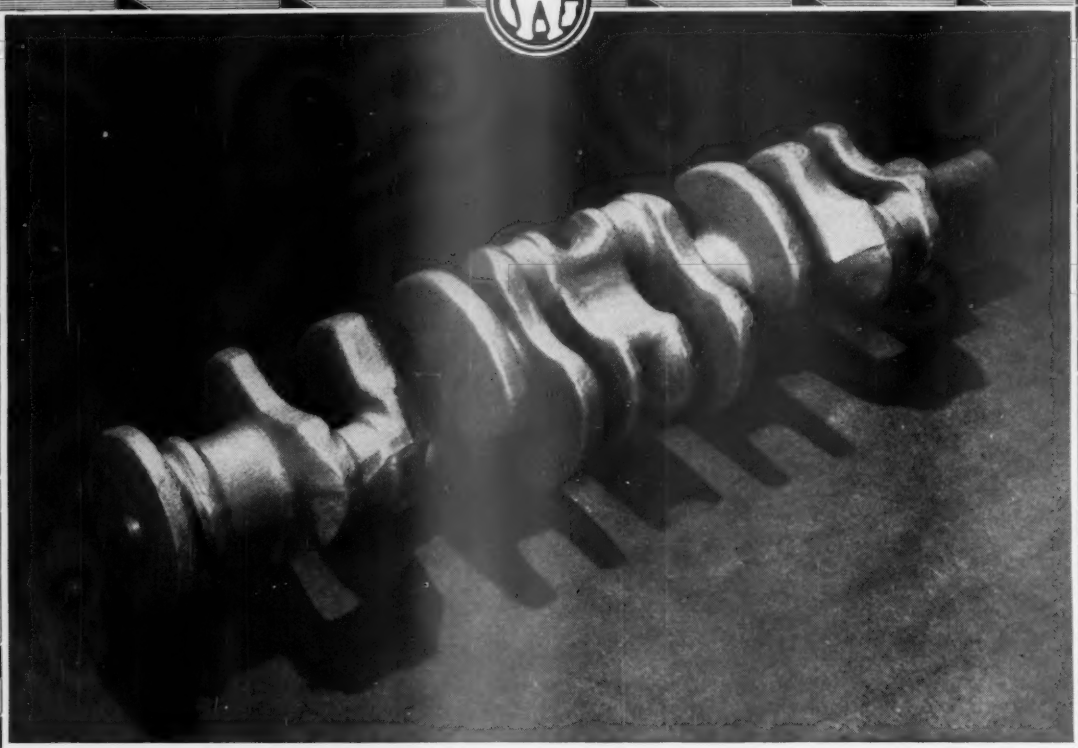

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Cover—The new Convair-Liners.

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Published Monthly by the Institute of the Aeronautical Sciences, Inc.

From High-Speed Bombers to High-Speed Transports

MARTIN LEADS THE WAY INTO THE FUTURE!

YESTERDAY: The famous Martin B-10 bomber, faster by 100 m.p.h. than any other bomber of its day and speedier than most pursuit ships, made obsolete nearly all the world's military aircraft; won the 1932 Collier Trophy for Glenn L. Martin.

TODAY: The Martin 2-0-2 as a military transport can carry 61 military personnel or more than 15,000 pounds of military cargo—over twice the capacity of twin-engine equipment used in World War II and still in service. And the 2-0-2 cruises at speeds 100 m.p.h. faster than the World War II planes it replaces . . . yet operates from the same short runways, small airports.

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Martin engineers are constantly at work harnessing higher and higher speeds to the transport and combat needs of our Military Services. In the days to come, look to Martin for rotary wing aircraft and other swiftly developing fields.

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"FLAK BAIT," **Devon Francis' new book, is the thrilling story of the heroic men who flew and serviced Martin B-26 Marauders in bomber strikes from the Southwest Pacific to the gates of Berlin. We are proud to be mentioned with these gallant men.**

I.A.S. News

A Record of People and Events of Interest to Institute Members

I.A.S. Lets Contracts for Los Angeles, San Diego Buildings

Work Started Immediately As President Northrop Makes Announcement; Both Projects Unanimously Approved by I.A.S. Council

AFTER MANY MONTHS of negotiation and of careful study by I.A.S. Building Committees and the Council, building contracts have been let for both the Los Angeles and San Diego facilities. Work was started immediately as the letting of the contracts was announced by President Jack Northrop.

The projects both were finally submitted to the I.A.S. Council at its meeting in Los Angeles on July 14 and were subsequently approved by a poll of the entire Council, President Northrop said. The Los Angeles contract was let August 8 and that for San Diego on August 19.

▸ **Fleet Key Project Figure**—It was Major R. H. Fleet who, as President of the Institute in 1944, first sparked the project of the West Coast facilities. It was during his term of office, also, that the I.A.S. main office obtained its present headquarters at 2 East 64th Street, New York City. Although funds for all three projects were raised at that time it was impossible to start action on the West Coast facilities because of wartime building restrictions. Within the last year, however, as restrictions were lifted and materials became more available, both the Los Angeles and San Diego Sections pushed the projects through to completion in spite of high material and labor costs and other obstacles.

▸ **3 L. A. Committees**—In Los Angeles, three committees worked to complete the project in that city. Willis M. Hawkins, Section Chairman, headed the Advisory Committee composed of Jack Northrop, A. E. Raymond, Clark B. Millikan, Hall E. Hibbard, J. L. Atwood, F. V. Wagner, M. A. Minor, J. C. Silliman, and L. E. Root. Jim Straight, I.A.S. Western Region Manager, served as Staff Member.

The Building Committee was composed of B. G. Reed, Chairman; Philip Colman; A. L. Klein; Dale D. Myers; and E. E. Sechler.

H. W. Strangman chairmanned the Contributors Committee, members of which were as follows: M. S. Gelber, J. P. McNamara, and J. R. Janssen.

The Los Angeles building is to be located on Beverley Blvd., between Stanley and Spalding Aves.

▸ **San Diego's Scenic Site**—A Building Committee of the San Diego Section was appointed in September, 1947, and, headed by E. P. Rhodes, worked diligently on architectural plans and building sites.

The result of these efforts was a set of plans and specifications for a beautiful and economical building located on scenic Harbor Drive, which skirts the San Diego harbor from Point Loma to Palm City. Approximately $^1/_2$ mile from the Civic Center and 1 mile from San Diego's downtown section, the site is directly across from the proposed new airport terminal building.

The site was selected as a part of the overall Harbor Drive planning by the city, and the style of the architecture is in harmony with these development plans.

Members of the Building Committee, of which Mr. Rhodes was Chairman, included Ralph Bayliss and Joel Whitney.

Benjamin T. Salmon, Chairman of the San Diego Section, worked closely with the committee.

The Contributors Committee, on which fell the work of organizing financial support of the project, was composed of the Chairman, H. I. Mandolph, and members S. W. Shepard, J. M. Whitney, and J. L. Oatman.

R. H. Fleet

National Meetings Calendar

December 17	Wright Brothers Lecture, Washington, D.C.
January 24–27	Seventeenth Annual Meeting, New York

"Historical Associate" Grade of Membership Approved by I.A.S. Council

A NEW GRADE OF MEMBERSHIP, known as "Historical Associate," has been established with the approval of the Council of the Institute in recognition of collectors and others interested in aeronautica and aeronautical history. The new grade is nonvoting, and dues of $10 per year include the quarterly publication of the Aeronautical Archives Committee. Age limit for Historical Members is 18 or over.

▶ **Fund Set Up**—The Council set aside up to $4,500 for 12 months to service the new grade of Historical Associate. W. A. M. Burden, Chairman of the Aeronautical Archives Committee, explained that the budget provides for a full-time person stationed in the New York headquarters Museum to handle Museum attendance, inventory and cataloging, and details of proofreading and dummying in connection with the quarterly publication.

Through the new membership, it is planned to increase the historical holdings of the Archives without conflicting with the regular technical activities of the Institute.

▶ **Two Resolutions Passed**—The I.A.S. Council, in approving the new membership grade, passed two resolutions as follows:

- *Resolved*, that a new section be added to Article I of the By-Laws as follows: Historical Associate members shall be persons over 18 years of age interested in the history of aeronautics and related sciences, and the collection and preservation of historical aeronautical material. An applicant for this grade must submit proof of his interest and shall be recommended by three persons, one of whom shall be a member of the Institute. All applications must be approved by the Aeronautical Archives Committee. And be it further
- *Resolved*, that the Director be authorized to expend up to $4,500 of Institute funds for a period of 12 months to service this grade of membership.

Members of the Institute will, as in the past, have available to them all present and future facilities of the Aeronautical Archives. Members are requested to assist in the support of this project by informing eligible individuals of the new grade of Historical Associate.

Members of the Aeronautical Archives Committee, of which Mr. Burden is Chairman, are: Preston R. Bassett; Col. R. C. Gimbel; Erik Hildes Heim; Casey S. Jones; Bella C. Landauer; Arthur G. Renstrom; E. W. Robischon; S. Paul Johnston; Robert R. Dexter; and Maurice H. Smith, Acting Secretary.

Tentative Program Set for Joint I.A.S.-R.Ae.S. Meet

A projected program for the joint meeting of the Institute and the Royal Aeronautical Society next May has been developed in discussions between the Director, S. Paul Johnston, Dr. T. P. Wright, and others, and was submitted to Capt. J. Laurence Pritchard, R.Ae.S. Secretary, for comment and suggestions.

A formal invitation to the Royal Aeronautical Society to participate in the proposed meeting was carried to London by Allan D. Emil, I.A.S. Counsel, on a trip abroad.

▶ **Tentative Program**—The draft of the tentative program, which is scheduled for May 24 through the 26, is as follows:

- Personal Plane Symposium (four papers) and Flight Test (three papers) in the morning of the first day; Rotating Wings (three papers) and Materials (four papers) in the afternoon; divided into two morning and two afternoon sessions of the first day.
- Power Plants (three papers) and Aerodynamics (three papers) divided into morning and afternoon sessions of the second day.
- On the third day, Air Navigation Aids (three papers) and Structures (three papers) are scheduled in two morning sessions. Final session in the afternoon will be devoted to an Air Transport Design Symposium (four papers).

Airborne Instruments Lab. Establishes Two Fellowships

Airborne Instruments Laboratory, Inc., has established two fellowships to aid worthy young men in obtaining advanced degrees in the field of communications and electronics, it was announced in August.

To be known as the Airborne Instruments Laboratory Fellowships, one is in the amount of $1,000 plus tuition at Stanford University, Palo Alto, Calif., and the other, in the amount of $1,200 for a single man or $1,800 for a married man, plus tuition, is at the Massachusetts Institute of Technology.

▶ **High Scholarship Required**—Recipients of these fellowships will be selected by the staffs of the electrical engineering departments of the two schools. They will be awarded on the basis of high scholarship but also with some consideration of the applicant's personality and need for financial assistance.

The donor has not dictated any particular problems in the field of communications and electronics but, other things being equal, has expressed a preference that the awards be made to men who are interested in broadband high-frequency systems, including filters, transmission lines, and vacuum-tube generators or amplifiers.

Papers of T. S. C. Lowe

Through the courtesy of his grandchildren, represented by Henry Lowe Brownback, the papers of Prof. Thaddeus S. C. Lowe have been added to the I.A.S. collections. Over half of approximately 1,500 pieces in this collection are letters, telegrams, and field dispatches, many of them pertaining to the operations of the Balloon Corps of the Union Army in 1861, 1862, and 1863. The collection includes a number of photographs, including negatives, several original drawings, maps, newspaper and magazine clippings, typescripts of articles and speeches by Professor Lowe, and copies of the various pamphlets issued in connection with his balloon enterprises.

Gifts to the Institute Collections

Models of the D558-1 Skyrocket and the D558-2 Skystreak were rereceived from the Douglas Aircraft Company, Inc., through the courtesy of E. H. Heinemann. Six balloon prints were received from Sherman M. Fairchild. Preston R. Bassett gave two Austrian aeronautical medals. Newspaper clippings on international air transport were received from J. C. Gardiner. Erik Hildes Heim gave sheet music and a medal of the opening of Idlewild Airport. An identification poster for aircraft of World War I was received from Miss Elizabeth T. Agnew. The insignia of Empire Airlines were received through the courtesy of N. L. Weiss. A copy of his recent article on Étienne de Lorimier was received from Prof. Michel N. Benisovich.

W. A. M. Burden added 200 periodicals to his previous generous gifts. Howard A. Scholle added bound volumes of reports and over 200 periodicals to his previous gifts. Lt. Col. F. E. Loudy gave over 400 aeronautical reports. John Walter Wood added pictures and publications and his well-known airport model to the airport collection previously given.

A file of the *Royal Aero Club Gazette* was received through the courtesy of H. J. Cooper. Technical reports and periodicals were sent by Cornell Aeronautical Laboratory, through the courtesy of Miss Elma T. Evans; by American Airlines, Inc., through the courtesy of Miss Dorothy Lalley; and by Eclipse-Pioneer Division of Bendix Aviation Corporation, through the courtesy of Miss Mildred M. Baker. The Propeller Division of Curtiss-Wright Corporation added aeronautical reports to its previous gifts. A number of its reports was sent by the National Luchtvaartlaboratorium, of Amsterdam. Four of its bibliographies were sent by Armstrong Siddeley Motors, Ltd., through the courtesy of M. K. Hanson.

Manuals and handbooks were received from Consolidated Vultee Aircraft Corporation; Continental Motors Corporation; Douglas Aircraft Company, Inc.; Grumman Aircraft Engineering Corporation; Lockheed Aircraft Corporation; Northrop Aircraft, Inc.; and the Chance-Vought Aircraft and Pratt and Whitney Aircraft divisions of United Aircraft Corporation.

Among other donors were Jose Garcia de Souza, Mrs. Bella C. Landauer, Dr. Alexander Klemin, and W. Ker Wilson.

Necrology

Mac Van Fleet Short

Mac Van Fleet Short, a Fellow of the Institute and a Vice-President of Lockheed Aircraft Corporation, died August 13 at the age of 51.

A founder of the Stearman Aircraft Company in Wichita, Kan., in 1927, and of the Vega Aircraft Company in Burbank, Calif., 10 years later, Mr. Short was a veteran of 30 years in the aviation industry.

▶ **Taught at M.I.T.**—Following service in the Army Air Corps which he entered in 1917, Mac Short was graduated from Kansas State College in 1922. He taught aeronautical engineering at Massachusetts Institute of Technology, where he received a Master's degree in 1927. He was born in Wichita.

Mr. Short became a close associate with Robert E. Gross, now President of Lockheed Aircraft, in the Stearman enterprise.

He was in college when this country entered the first World War, receiving ground instruction at the University of Illinois and flight training at Love Field, Dallas, Tex. He was with a bombing squadron when the Armistice was signed.

After the war he barnstormed during the summer, at the same time continuing his studies at college. After leaving Kansas State he joined the Air Mail Service and was an aeronautical engineer at McCook Field.

Mac Short

▶ **Designed Trainer**—In the last war, Mr. Short designed primary training planes and participated in planning the Lockheed Ventura and Neptune Navy patrol bombers.

The Society of Automotive Engineers elected him its 38th President in 1943, marking the first time the honor had gone outside of the automobile industry.

I.A.S. Newslines

▶ Dean of Seminary . . . **Dr. Nicholas Alexander,** who has been Professor of Aeronautical Engineering, Rhode Island State College, is now Dean of Holy Trinity Orthodox Seminary. He is an Associate Fellow of the Institute.

▶ **Warren V. Boughton,** formerly Douglas Aircraft's Chief of Equipment Section, has been elected Vice-President and General Manager of Phaostron Company.

▶ Elected R.Ae.S. Fellow . . . **Charles Chapleo,** Chief Structures Engineer, Airspeed Ltd., England, was elected a Fellow of the Royal Aeronautical Society last April. Mr. Chapleo is an Associate Fellow of the Institute.

▶ New N.A.F. Engineer . . . Having completed a Logistics Course at the Naval War College, Newport, R.I., Associate Fellow **Comdr. Oliver H. Cote, Jr.,** reported for duty at the Naval Air Material Center, Philadelphia, as Assistant Chief Engineer (Airplanes & Specialties) at the Naval Aircraft Factory.

▶ Miscalculation of Optimism . . . **Sir Roy Fedden,** Honorary Fellow and one of Britain's top aeronautical engineers, said there has been a miscalculation of optimism with regard to the propeller turbine which has resulted in nearly all work being shut down on British 4,000–5,000-hp. piston engines, "which is nothing short of a national disaster." In a stern warning to the British not to place too complete a reliance on as-yet unproved prop-jet power plants, Sir Roy said the reciprocating engine, "for certain purposes, must of necessity be with us for several years yet, and if we do not wake up to this fact quickly, we are going to rue the day."

▶ Leaves Fairchild . . . Associate Fellow **John Paul D. Garges** resigned from Fairchild Personal Planes Division to become Chief Engineer, East Coast Aeronautics, Inc.

▶ Gambling With Security . . . Speaking before the California Wing of the Air Force Association, **Gen. George C. Kenney,** Honorary Member, warned that World War II is already out of date. Said General Kenney: "If we stop thinking, stop inventing, and

(*Continued on page 9*)

Silicone News

DC

Silicones Save Cylinder Heads from Corrosion

Cylinders of new Harley-Davidson "2-Cycle" motorcycle protected from rust by modified silicone coating formulated by Midland Industrial Finishes Co.

PHOTO COURTESY HARLEY-DAVIDSON MOTOR CO.

Rusting of metals exposed to high temperatures and moisture was once as certain as taxes. That was before silicones were introduced by Dow Corning Corporation. In all of their various forms, these organo-silicon oxide polymers are indifferent to extreme heat or cold—and they repel water.

That's why the Harley-Davidson Motor Company of Milwaukee, Wisconsin, tested and then finally specified a modified silicone coating formulated of Dow Corning Silicone Resins for the cylinders of their new Model 125 motorcycles. Preliminary tests showed that the Modified Silicone Aluminum Coating made by Midland Industrial Finishes Company of Waukegan, Illinois, maintained its film continuity even after being exposed to 1000°F. and plunged into water, 70°F. Immersion in water for 24 hours resulted in no appreciable softening, blistering, rusting or discoloration of the coating.

The coating was then applied to the cylinders and exhaust pipes of a 1948 Big Twin motorcycle, and the motorcycle was driven 1,893 miles. The cylinders retained their original new appearance with the exception of slight oil burns. The coating was tough and resistant to scratching. It did not soften when cleaned with gasoline or naphtha.

This is only one of the many applications in which DC Silicone Resins help to prevent rusting of hot metal surfaces. These silicone resins are described in Data Sheet No. S8-2.

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Corporate Member News

• In the Black . . . Consolidated net profit of the **Curtiss-Wright Corporation** for first 6 months of 1948 was $2,681,367 compared with net loss of $241,837 in same period last year. Net sales totaled $49,716,997 against $38,687,453 in the 1947 period.

• Cargo Fleet Tripled . . . **Eastern Air Lines, Inc.,** has tripled its fleet of cargo planes, increasing capacity by more than 2,000,000 lbs. per month. Four C-54's were added to Eastern's equipment last month, provided with new "tie-down" technique in form of metal net, developed by company, which will hold cargo securely in place and permit heavy and fragile packages to be separated, eliminating possibility of crushing and expediting unloading on arrival.

• Al-Fin License Granted British . . . **Fairchild Engine & Airplane Corporation** has concluded a licensing agreement, covering use of Fairchild's Al-Fin process for bonding aluminum to iron, steel, and other metals, with Wellworthy Piston Rings Ltd. of England. It is first foreign license granted for the Al-Fin process and fourth license in recent months.

• Backlog Up 16 per cent in Six Months . . . **The Glenn L. Martin Company** reports its backlog of orders increased about 16 per cent for the first 6 months of the year, a jump from $105,000,000 to $122,000,000. New orders received in the 6-month period were for additional P4M-1 Mercators, turrets, fire-control equipment, modification work, and rockets . . . New giant experimental turboprop-powered flying boat project is under way at the Martin plant for the Navy. New boat, XP6M, will be larger than the Mars (145,000–160,000-lb. gross weight).

• Calling Engineers . . . Engineering department of **Northrop Aircraft, Inc.,** faced with a heavy backlog of military design and development work, has been canvassing the nation for 400 more engineers. Company expects to employ a total of 1,500 to accommodate long-term contracts, compared with 650 persons in engineering department at peak of Black Widow program in last war, and 1,100 on payroll as Northrop began calling for engineers.

• Opening New Era . . . Installation of a Sperry-built engine analyzer in the 75-passenger Boeing Stratocruiser by **Pan American World Airways System** is expected by the air line to eliminate 60 per cent of delays in flight departures caused by engine troubles. Declared André A. Priester, Vice-President and Chief Engineer for Pan Am, an I.A.S. Fellow: "The engine analyzer will literally open a new era of air-line maintenance. The new analyzer is the first complete instrument provided for commercial aircraft to isolate detailed engine difficulties." Analyzer locates and identifies any malfunctioning part within the engine during flight . . . Pan Am's Latin American Division is adding 1,500 employees to 4,000 already on Miami roster to handle increased work at the Miami Overhaul Base.

• Foundation work has been started on the big new turbine laboratory near the recently completed Pratt & Whitney compressor laboratory on the bank of the Connecticut River. New lab being built by **Pratt & Whitney Aircraft Division,** United Aircraft Corporation, will be used to test, under simulated flight conditions, prop-jet and turbojet engines and their components. Building will have maximum length of 485 ft. and maximum width of 166 ft.

• Business Picking Up . . . **Republic Aviation Corporation** ended first half of 1948 with net profit after taxes of $1,826,972—compares with net loss of $476,205 for first 6 months in 1947. Sales for the half year amounted to $27,138,207. Backlog of A.F. orders is $39,000,000, with letter of intent which should add $42,000,000 more to Republic's current business.

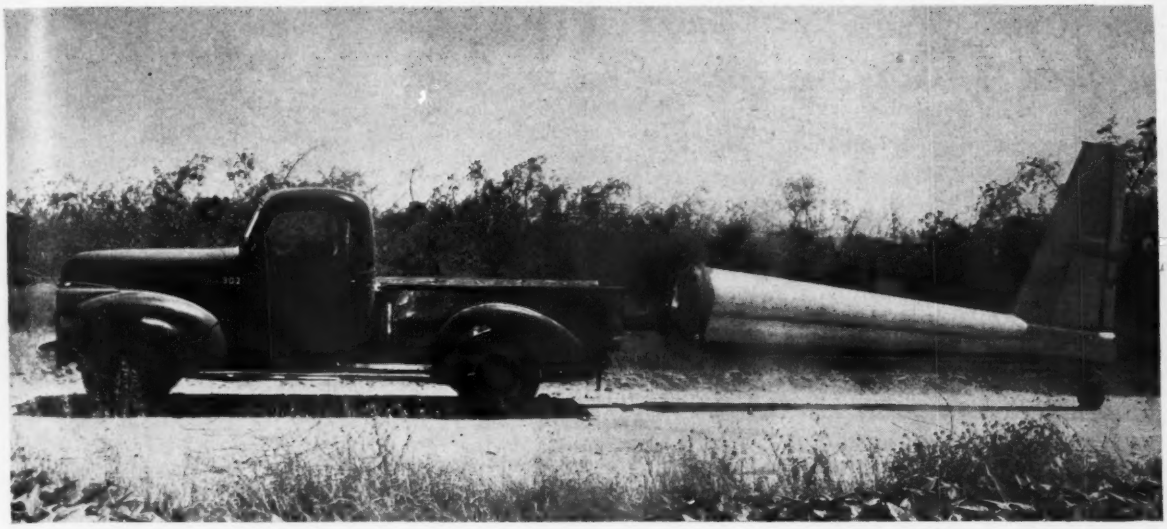
• Another Ryan distributor, three more factory dealers for the four-place Navion have been appointed by the **Ryan Aeronautical Company.** Mountain States Aviation, Inc., Denver, will handle distribution for Colorado and southern Wyoming. Skymotive, Inc., East Los Angeles Airport; Signal Aviation Corporation, Long Beach Municipal Airport; and Conejo Valley Airport, Camarillo, Calif., received direct-factory dealer appointments.

• For "Fish" Studies . . . An intensified research program in atomic energy and fundamental structure of matter at Massachusetts Institute of Technology is made possible by a grant of $250,000 by the **Socony-Vacuum Oil Company, Inc.** Grant will be made at rate of $50,000 per year for 5 years and will be utilized at M.I.T.'s discretion to provide facilities and scientists for carrying out the work involved in solving problems in nuclear fission.

• A 40-per cent increase in current facilities at **The Texas Company's** research laboratories in Beacon, N.Y., will be provided by the construction of three new buildings at that location. A new engineering building will contain labs for volatility, lubrication, and combustion studies; a chemistry building will contain 18 entire laboratories for further development of new lubes; and a third building will provide office space and required services for carrying on activities of new units.

• Weather "Huddle" . . . A centralized weather information bureau has been put into operation by **United Air Lines, Inc.,** in Denver. Company officials gather each morning in a special room at the Stapleton Airfield Base, review past weather conditions, study the present, and prepare forecasts for coming operational day. While flight operators make plans to cope with any unusual weather problems, meteorologists at other stations are contacted by phone or teletype for discussion of special points. After intensive study of all available weather intelligence in Denver, including that of the U.S. Weather Bureau, the chief meteorologist prepares special forecasts for United's operations. This "huddle" method is said virtually to rule out possibility of conflicting predictions by far-flung meteorologists. Mile-by-mile supplemental information is radioed on by pilots flying the various routes.

• Profit for 3-month period ending June 30 of $382,004 was announced by **Wright Aeronautical Corporation,** with a dividend of $5.00 per share payable November 30 to stockholders of record November 15. Net sales for the period were $13,162,241 . . . Wright's prop-jet T-35 Typhoon was test-flown in nose of specially reinforced B-17. All four piston engines of the B-17 were dead in the test.



SHIMMY TEST

A 25-hour road test was conducted by a research engineer of Consolidated Vultee Aircraft Corporation to make sure a redesigned tail-wheel installation on the L-13 liaison planes would stand up under rugged operational service without shimmy or failure. At conclusion of test, which consisted of towing the aft section of an L-13 behind a pickup truck at varying speeds of from 10 to 40 m.p.h., the installation was said to be in excellent shape after 724 miles of shimmy-free travel over some of the bumpiest roads in southern California. New design has a preloaded, compensated hydraulic cylinder that prevents tail-wheel shimmy by changing the oscillation frequency of tail-wheel fork.

I.A.S. Newslines

(*Continued from page 7*)

stop developing even for 1 year, we will be gambling with our national security. In air warfare technical superiority of equipment more than compensates for mere numbers. If we try to maintain an obsolete military establishment, we won't have enough money left to develop, procure and maintain a modern force."

▶ Never Expected Stairs. . . As special representative of Gen. Hoyt S. Vandenberg, Air Force Chief of Staff, **Col. Charles A. Lindbergh,** I.A.S. Fellow, discussed important engineering and development work at Boeing-Wichita. Inspecting a Stratocruiser, Lone Eagle remarked: "I never expected to live to see the day when I could walk up and down stairs in an airplane."

▶ Moves East . . . Associate Fellow **Earl F. Loudy** has come east from Continental Motors Corporation to Grumman Aircraft Engineering Corporation as Chief Aeronautical Engineer, U.S. Navy office.

▶ Changeover . . . **Walter F. McGinty,** Associate Fellow, resigned as Vice-President and General Manager of Lowe Construction Company, Inc., to become Vice-President and General Manager of National Aircraft Maintenance Corporation.

▶ McDonnell Aircraft Corporation has appointed **Robert R. Osborn** Chief Engineer of its Helicopter & Propulsion Division. Associated with McDonnell since November, 1943, as Consulting Engineer, Osborn is a Fellow of I.A.S., an Associate Fellow of the Royal Aeronautical Society, and a helicopter subcommittee member of the National Advisory Committee for Aeronautics.

▶ **Walter A. Semmion,** formerly Research Engineer at Willys Overland Motors, is a Designer at Lockheed Aircraft Corporation. He is an Associate Fellow.

▶ Native Son . . . As 200 jet, Thunderbolt and Mustang fighters, and B-29's roared overhead, Berks County, Pa., honored a native son, **Gen. Carl Spaatz,** retired Air Force Chief of Staff. Born in Boyerton, and the county's most distinguished soldier, General Spaatz told 25,000 cheering spectators: "An ocean of air has replaced the oceans of water as our fleet first line of defense. It is consequently of the highest importance that the U.S. dominate the air as it formerly dominated the sea. Our air force must be made the largest in the world."

▶ Forms Own Company . . . **Robert M. Stanley,** a Fellow and former Vice-President in charge of Engineering for Bell Aircraft, has formed his own company, the Stanley Aviation Corporation, which will do general aircraft engineering design and research in guided missiles and allied military fields. Company starts with Navy contract totaling about $100,000 for electronic instruments. Stanley, who resigned from Bell last spring (AERONAUTICAL ENGINEERING REVIEW, July, 1948), has gathered 22 former Bell employees into the new company.

▶ Change in Title . . . **Ernest G. Stout's** title in the Convair setup now reads, Assistant to the Chief Engineer. In this position he is responsible for all Naval research, development, and sales for Consolidated Vultee, which is in line with new company policy of placing military sales under engineering department where it can be more closely integrated with development and research. Stout, an Associate Fellow, previously was head of Naval Aircraft Research.

Meet Your Section Chairman

Benjamin T. Salmon

San Diego Section

A transplanted New Englander with a good root-hold in California, Benjamin T. Salmon, Assistant Project Engineer for Consolidated Vultee Aircraft Corporation, started work as an airplane mechanic for Robert S. Fogg at Concord, N.H., in 1927.

▶ **Attended M.I.T.**—Born December 24, 1911, at Georgetown, Mass., Ben Salmon was graduated from Concord, N.H., high school, took postgraduate work at Boston English High in Boston, and then entered Massachusetts Institute of Technology in October, 1930, where he studied until June, 1933.

In the meantime he operated engine overhaul shops at East Boston Airport and had the first authorized Wright Aeronautical overhaul station there. Previously, in Concord, N.H., he had become a licensed A&E Mechanic while working for Fogg.

▶ **A.T.C. on Sport Plane**—In August, 1933, Mr. Salmon moved to Downey, Calif., where he was made Chief Engineer of Security Aircraft Corporation, of which W. B. Kinner was President.

In that capacity he obtained an A.T.C. on the Security Airster, a folding wing sport monoplane.

He then accepted appointment as Chief Engineer of Bowlus DuPont Sailplane Company, San Fernando, in October, 1933, where he designed and obtained A.T.C. on the Albatross and Falcon high-performance sailplanes.

In July, 1934, he took time out to get married to Mary Emma Sylvester of Colorado. They now have two daughters.

▶ **Joins Northrop**—Starting the New Year as Group Engineer—Armament at Northrop Aircraft Company, El Segundo, Ben Salmon designed an automatic gun charger (later sold to Walter Kidde & Company) and designed armament installation in the Northrop 3-A Army pursuit plane.

Leaving Northrop in April, 1935, he joined Airplane Development Corporation as Assistant Chief of Stress, working on stress analysis of the Vultee V-11 attack bomber.

Loaned by Airplane Development to Kinner Airplane & Motor Corporation the following October, he designed and projected the Kinner 25C-7 twin-engined eight-place feeder-line transport.

▶ **Designed P-38**—In June, 1936, he was with Vultee Aircraft Division, Aviation Manufacturing Corporation (which had acquired Airplane Development Corporation) as Chief of Structures, Aerodynamics, Flight Test and New Design, at Downey. There he revised the stress analysis of the V-11 for a Russian order and developed cruising charts for the Russian V-1A on floats, which flew over the North Pole to Moscow. He also developed cruising charts for the plane "Lady Peace" which Capt. Dick Merrill and Harry Richman flew to Spain and back.

While with Vultee Aircraft, Salmon laid out the design of a twin-engined fighter that was the basis for the XP-38.

Named Project Engineer by Lockheed Aircraft Corporation, he designed Model 22, which won the Air Corps Interceptor competition and became the XP-38, which he redesigned into the YP-38.

▶ **Goes East**—In September, 1939, The Glenn L. Martin Company in Baltimore made Ben Salmon Project Engineer, and in that capacity he designed the Model 187 "Baltimore" for the French. While with Martin he was assigned to design a heavy bomber, which became the XB-33.

Returning to the West Coast in January, 1942, he joined Ryan Aeronautical Company as Chief Engineer designing the XFR-1, composite-powered Navy fighter; the XF-R-4; XF2R-1; XF2R-2, high-speed target drone; MX-799, Bureau of Ordnance "Kingfisher" studies; etc.

In July, 1947, he went to San Diego and Consolidated Vultee Aircraft Corporation.

An amateur pianist, Ben Salmon also has taken up gardening and landscaping as hobbies, developing a $^3/_4$-acre terraced hillside, subtropical fruit orchard of 80 trees, each of a different species or variety. In addition, he makes unique household items of furniture.

Smith J. De France

San Francisco Section

Employed by the National Advisory Committee for Aeronautics since 1922, Smith J. De France, Chairman of the I.A.S. San Francisco Section, is a Vice-President and Fellow of the Institute, and Director of Ames Aeronautical Laboratory, Moffett Field, Calif.

▶ **World War I Pilot**—Entering the University of Michigan in September, 1915, Smith DeFrance's education was interrupted 2 years later by the first World War when, in 1917, he learned to fly in the Royal Canadian Flying Corps.

He was a pilot and Flight Commander of the 139th Aero Squadron of the Aviation Section of the U.S. Army Signal Corps from February, 1918, to March, 1919, receiving a citation from the Commanding General of the American Expeditionary Force.

Returning to Michigan as a reserve military aviator and junior airplane pilot after his discharge from the service, Mr. De France completed his education, receiving a Bachelor of Science degree in Aeronautical Engineering in 1922. Shortly after, he married Miss Ruth Patterson of St. Johns, Mich.

▶ **Wind Tunnel Research**—The N.A.C.A. appointed him a Junior Aeronautical Engineer at its Langley Field Laboratory in 1922, and he did research work in wind tunnels and with the flight research group until 1929, when he was placed in charge of construction of the Full Scale Wind Tunnel.

He then supervised research in the Full Scale Tunnel and other wind tunnels at Langley Field and at the same time was in charge of construction of research facilities.

In 1940 he was assigned to supervise construction of N.A.C.A.'s Ames Aeronautical Laboratory at Moffett Field and to organize the research staff. Mr. De France has been in charge of the Ames Lab. since then.

▶ **Awarded Medal for Merit**—For his work during World War II, he was awarded the Medal for Merit. He has written various N.A.C.A reports.

In addition to his Fellowship in the Institute, Mr. De France is a member of the Quiet Birdmen. He was born in Battle Creek, Mich., in 1896.

I.A.S. Sections

Dayton Section

E. W. Robischon, *Secretary*

Following a dinner attended by some 40 members and guests at the Dayton Engineers Club July 29, the Section heard a talk by Leslie E. Neville, Director, Standard Aeronautical Indexing System, and former Editor of *Aviation*.

▸ **Power Available**—Mr. Neville spoke on "Jet Propulsion and Its Significance in the Future of Aviation," drawing upon the Scriptures for several pertinent quotations.

From the time of the Wright brothers, he said, the basic problem of the aircraft designer has been "power available." Through the years we have witnessed the spectacle of reciprocating engine designers striving always to squeeze a little more power out of their engines. Now, the best we can do with reciprocating engines is to add more cylinders, the speaker said.

▸ **"Gnashing of Teeth"**—The impact of jet propulsion on the consciousness of the reciprocating engine industry, Les said, is best expressed in Luke 14:28:

"And there shall be weeping and wailing and gnashing of teeth when ye shall see the thrust."

With the advent of the gas turbine, the problem of power available becomes far less critical. In the short history of gas-turbine design, there have been many instances of doubled power output and there seems no limit in sight, he declared.

The problem of high fuel consumption in jet engines is not so acute as generally thought, the speaker believed. "Present gas turbines are about 30 per cent more efficient than those built only a few years ago." It is not unreasonable, he went on, to expect another drop of 20 per cent for the simple cycle turbojet within the next few years as a result of refinements in design.

▸ **British Progress**—Pointing out that we lag behind the British in the jet commercial transport field, Les said: "While we are writing papers about such machines, our British cousins are actually flying turbine-powered transport prototypes."

And next February the Avro (Canada) C.102 is scheduled to make its first flight tests. This has been designed from scratch for jet propulsion power with a cruising speed of 400 m.p.h. and a medium range.

San Diego Section

Ralph H. Shick, *Secretary*

The principal speaker at the July 6 meeting of the Section was E. S. (Tommy) Thompson, Assistant Manager of Aircraft Gas Turbine Division, General Electric Company.

▸ **British-American Jet Status**—Mr. Thompson, who was one of a group of men who initiated, at A.A.F. request, the manufacture of the turbojet engine in the United States, presented a talk on "The Current Status of British and American Aircraft Gas-Turbine Development."

A recent visit to England provided him a coordinated picture of the gas turbine both here and abroad.

▸ **All-Wing Aircraft**—Approximately 220 members and guests heard an interesting talk on the development of all-wing aircraft at the August 19 meeting. The meeting, which included a dinner, was held in the dining room of the Marine Corps Officers Club.

Joel Whitney, Chairman of the Section Meetings Committee, introduced the speaker, John K. Northrop, President of Northrop Aircraft, Inc., and President of the Institute of the Aeronautical Sciences, who presented an excellent talk titled "Development of All-Wing Aircraft, with Latest Progress Notes." Mr. Northrop outlined the comparisons of all-wing aircraft with conventional aircraft, illustrating his talk with a technicolor movie showing flight pictures of the various all-wing aircraft that have been developed by Northrop Aircraft during the past few years.

▸ **New I.A.S. Building**—One of the outstanding phases of the meeting was an announcement by Mr. Northrop that plans had been completed, and the contract signed, for construction of the Institute of the Aeronautical Sciences building on Harbor Drive in San Diego and that construction would actually commence during the week of August 23.

Student Branches

Aeronautical University

Three films were shown at the July 1 meeting of the Branch, Chairman McDermott presiding. There were 82 members present. The films were: *Jet Propulsion*, *Gliding Wings*, and *The History of Willow Run*.

At the July 8 meeting three proposed amendments were read and passed by the members, 110 being present.

The August 5 meeting also was principally business, but included the showing of a film on the F-80 Shooting Star.

Academy of Aeronautics

Two speakers were heard at the July 14 meeting: John T. Korbuszewski, the Chairman, who spoke on the initial flight of the X-1 through the speed of sound; and Francis Omilian, who described the recent development of atomic energy and its application to aircraft turbojet engines.

Election of officers took place at the July 28 meeting with the following results: Chairman, John P. Kielp; Vice-Chairman, Walter E. Thielhart; Secretary, Philip E. Greenberg; Treasurer, Dan Cottone; Sergeant-at-Arms, Edward J. Alshut.

University of Alabama

Following a business session at which programs, field trips, and social events were discussed and planned for the future, the Chairman, Thomas Wilder, spoke on the subject of "Inelastic Column Theory." A film, *The Winged Scourge*, concluded the meeting.

Cal-Aero Technical Institute

The meeting of July 15 was opened by Chairman Robert J. Cameron, who introduced the guest speaker, Charles F. Drexel, Preliminary Design Engineer, AiResearch Manufacturing Company.

Dr. Drexel spoke on "Aircraft Air Conditioning and Pressurization." The talk was supplemented by schematic drawings and photographs of air-conditioning and pressurized units.

Northrop Aeronautical Institute

First formal meeting of the new term was combined with the Annual Summer Meeting of the Institute.

News of Members

Clifton L. Adcock has been appointed as Aerodynamicist in the El Segundo Division of Douglas Aircraft Company, Inc. He was a student at Cal Tech.

John W. Anderson, formerly with Boeing Airplane Company as an Engineer, is now an Engineer with McDonnell Aircraft Corporation.

Dr. George P. Baker has been named Chairman of the Committee of Aeronautics, Dr. Vannevar Bush announced. Dr. Baker is Professor of Transportation of Harvard School of Business Administration.

Hans Bebie was named Structures Engineer, Boeing Airplane Company. He had been Senior Stress Analyst with The Glenn L. Martin Company.

Emery B. Brown, formerly with Chance Vought Aircraft, is with the Hartford Accident & Indemnity Company as an Engineer.

William Z. Bugielski resigned as Vibrations Engineer at Bell Aircraft to become SR4 Development Engineer, Baldwin Southwark Division, The Baldwin Locomotive Works.

Alfred M. de Neufville is an Instructor in Mechanics at Lehigh University.

Daniel O. Dommasch resigned as Assistant Professor, Aeronautics Department, Iowa State College, to accept appointment as Chief Engineer and Chief Instructor of the Test Pilot Training Division at the N.A.T.C., Navy Department, Patuxent River.

Lon Edmund Eagle is Engineering Draftsman "B," Lockheed Aircraft Corporation. He was with Johnson Aircraft as Junior Aircraft Engineer.

Walter M. Fitch has joined the Engineering Division as Laboratory Test Technician, Boeing Airplane Company, leaving Curtiss-Wright Corporation.

Charles M. Forsyth resigned as Project Engineer at N.A.C.A.'s Langley Laboratory to take post as Project Flight Test Engineer, McDonnell Aircraft Corporation.

Leonard S. Ganz, former Graduate Assistant, Guggenheim School of Aeronautics, New York University, is now Vibration Engineer, Piasecki Helicopter Corporation, Morton, Pa.

Newton C. Garland is Junior Engineer, Raymond Engineering Laboratory, Inc. He had been Research Engineer with United Aircraft Corporation.

John M. Genovese resigned from Chance Vought Aircraft as Senior Layout Design Draftsman to accept same position with Chase Aircraft Company, Inc.

Dr. Vishnu M. Ghatage resigned as Professor of Aeronautics, Indian Institute of Science to become Chief Designer, Hindustan Aircraft Ltd.

Arthur C. Gilbert resigned from N.A.C.A.'s Langley Laboratory as Research Aeronautical Engineer to take post as Stress Analyst, Piasecki Helicopter Corporation.

Arthur W. Gilmore, University of California Graduate Student and Engineer on Research, is Aerodynamicist, Pilotless Aircraft Group, Grumman Aircraft Engineering Corporation.

Jack R. Gipe resigned from The Glenn L. Martin Company as Engineering Draftsman to become Instrumentation Engineer, Chance Vought Aircraft Division United Aircraft Corporation.

Marvin M. Glenn is Designer, Engineering Department, Curtiss-Wright Airplane Division, Columbus Plant.

Glenn E. Graham, former Engineer with United Air Lines, Inc., is Engineering Designer "A," Boeing Airplane Company.

Jack I. Hamilton resigned as Assistant Sales Engineer, Curtiss-Wright Propeller Division, to take position as Project Manager, Frederick V. Lawrence, Inc.

Arthur St. G. Harris joined A. V. Roe Canada Ltd. as Weights Estimator. Mr. Harris, A.F.R.Ae.S., was Engineer, Mechanical Controls Group, Canadair Ltd.

Chester N. Hasert was named Senior Research Associate, Aerodynamics Mechanics Division, Naval Ordnance Laboratory, White Oak, Md.

William M. Hawkins, Jr., is Research Engineer, American Car & Foundry Company. He was Experimental Engineer in Charge of Experimental Department, Aircraft Engine Division, Packard Motor Car Company.

Mark F. Heaney, former Test Pilot, Bell Aircraft Company, has been promoted to Project Engineer.

Sanford H. Hinton resigned from Luttrell & Senior to become Flight Test Engineer, Civil Aeronautics Administration.

Arnold W. Hohensee, formerly with Darbyshire-Steel Company, Inc., is Designer, General Electric Company's Ordnance Research & Development Division.

Sales Manager: *Don K. Covington, Jr., has resigned his post as Project Flight Test Engineer with The Glenn L. Martin Company to take position as Assistant Sales Manager with the Harbor Sales Company, Inc., Baltimore. Don is Secretary of the I.A.S. Baltimore Section.*

William H. Houseworth has been commissioned a Major in the U.S. Air Force. He had been Aeronautical Engineer, Flight Propulsion Research Laboratory, N.A.C.A.

Frederick W. Howells resigned as Instructor in Aeronautical Engineering, Colorado University, where he was Graduate Research Fellow, to become Aerodynamicist, Consolidated Vultee Aircraft Corporation.

Constantine J. Janes is Flight Test Engineer, Flight Engineering Division, Civil Aeronautics Administration, having been promoted from Aeronautical Engineer.

Roger A. Johnson, former Engineer, Dispatch Oven Company, is Engineering Draftsman "A," Douglas Aircraft Company, Inc.

Rudolph A. Johnson, who was a student at Indiana Tech College, is Powerplant Engineer, Curtiss-Wright Corporation, Columbus Plant.

Colonel W. S. Johnston has been appointed commander of the 53rd Fighter Wing of the Pennsylvania Air National Guard.

Martin P. V. Kiebert, Jr., former member of the firm of Sherman Fairchild & Associates, is Engineering Department Head, Raymond Rosen & Company.

Norman A. Krause, with McDonnell Aircraft Corporation, has been named Assistant Flight Test Engineer.

Herbert F. Kueck resigned as Chief of Preliminary Design, Luscombe Airplane Corporation, to become Project Engineer Aeronca Aircraft Corporation.

Richard D. Le Clair, Graduate Student, University of Michigan, is Stress Analyst, Northrop Aircraft, Inc.

Seymour Z. Lobel, Purdue University student, has been named Aeronautical Engineer, U.S. Naval Air Development Station, U.S.N.

Robert G. Loewy, M.I.T. Graduate Student, is Vibrations Engineer, The Glenn L. Martin Company.

Richard L. Merrell, part-time Instructor and Grad Student, Louisiana State, is now a Graduate Student at Cal Tech.

James S. Murphy is Research Assistant, Supersonic Wind Tunnel, University of Michigan. He had been an Instructor at West Virginia University.

John D. Nicolaides, former Aerodynamic Project Engineer, General Electric Company, is Project Engineer, Ballistic Research Laboratory, War Department.

Clarence C. Pell has been named assistant to President, Flight Safety Foundation, Inc. Mr. Pell was Chief, Air Transport Section, Engineering Department, Aero Insurance Underwriters.

William B. Pepper, Jr., former Design Draftsman, Douglas Aircraft, is at Langley Memorial Aeronautical Laboratory, N.A.C.A., as Aeronautical Research Scientist.

John W. Peterson resigned as Research Assistant, University of Michigan, to take post as Research Engineer, Aerodynamics, Aerophysics Laboratory, North American Aviation, Inc.

William H. Podolny was made Analytical Engineer, Pratt & Whitney Aircraft Division, United Aircraft Corporation. He is a Rensselaer Polytech Grad Student.

Robert W. Rainey, former Research Assistant and Graduate Student, Georgia Tech, is Aeronautical Research Scientist, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Dr. James F. Reagan, former Parks College Aeronautical Engineering Department Head, is with Radioplane Company as Aerodynamicist.

Alfred Ritter is a Graduate Student at Cornell University. He had been at Georgia Tech as Research Assistant, Daniel Guggenheim School of Aeronautics.

William E. Roberts, Jr., former Assistant Design Engineer, McDonnell Aircraft, now is Structures Unit Head, Curtiss-Wright Airplane Division.

Irvine E. Ross, Jr., resigned from Victor Electric Products, Inc., as Chief Engineer, to become Assistant Division Engineer in Charge Aircraft, General Electric Company.

Henry C. Runkel is Group Engineer, Boeing Airplane Company. He resigned from Curtiss-Wright (Columbus), where he was Project Engineer.

Leonid Samuel, former Junior Engineer with Engineering & Research Corporation, is with General Electric Company as Supervisor.

Waldo H. Schock resigned as Instructor and Aeronautical Engineering Department Head, Indiana Technical College, to take position as Engineer-Structures, Curtiss-Wright Airplane Division.

George S. Sexton is Engineer, Bureau of Aeronautics, Navy, having resigned from Chance Vought Aircraft as Aerodynamics Engineer.

Samuel E. Slaymaker, III, is Research Associate, Aeronautical Engineering Department, Princeton University. He was Research Engineer with Bell Aircraft.

Norman Y. Smith resigned from Convair as a Stress Analyst to join North American Aviation, Inc., as Stress Analyst, Aerophysics Laboratory.

James B. Springfield former General Manager for Indiana Air Service, Inc., is Field Representative, Pratt & Whitney Aircraft Division, United Aircraft.

William Squire is Associate Physicist, Aerodynamics Research Section, Cornell Aeronautical Laboratory. He had been Assistant Physicist, National Bureau of Standards.

Robin Stevenson has been commissioned Lieutenant, Engineer, Procurement, U.S.A.F. He was with Goodyear Aircraft Corporation's Aerodynamics Section.

Leonard E. Stitt is Junior Engineer, Bendix Aviation Corporation.

Rodney W. Streed, former Purdue University student in Aeronautical Engineering, is Engineering Assistant "A," Consolidated Vultee Aircraft Corporation.

Develops Plastic Coated Prop: *Don Miller, Chief Engineer of the Flottorp Manufacturing Company, is credited with supervising the development of the new Flottorp plastic-coated propeller for personal and executive planes, as well as for the design of the production layout of the propeller.*

James P. Sturrock, Georgia Tech Graduate Student, is now with Consolidated Vultee Aircraft Corporation as Research Laboratory Analyst.

Harold R. Sweet is Structures Engineer, Curtiss-Wright Airplane Division. He was Instructor, Department of Rational & Technical Mechanics, Rensselaer Polytech.

Dino G. Valazza, former Superintendent of Flight Engineers, European Region, Transcontinental & Western Air, Inc., has been made Flight Engineer, Western Region, Los Angeles.

Merwin G. Wade, Purdue University Graduate Student, is Research Lab. Analyst, Ordnance Aerophysics Laboratory, Consolidated Vultee Aircraft Corporation.

Joseph G. Walsh, former National Bureau of Standards Engineer, is Performance Engineer, Grumman Aircraft Engineering Corporation.

Charles E. Wardman resigned as Engineer, Commercial Welding Works, to become Assistant Production Manager, Paramount Steel Corporation.

Paul Warsett is Engineer, Pilotless Plane Division, Fairchild Engine & Airplane Corporation. He was Professor of Aeronautical Engineering, North Dakota Agricultural College.

Charles L. White is Radio Operator at Kent County Airport, Grand Rapids, Mich., for Capital Airlines.

Richard P. White, Jr., Rensselaer Polytech Graduate Student, is Vibration Engineer, The Glenn L. Martin Company.

Howard R. Wright, Jr., former Lab. Instructor, Aeronautical Department, Tri-State College, is Engineering Science Student, University of Miami.

Necrology

Charles B. Lyman

Charles B. Lyman, one of the country's most prominent young men in aeronautical engineering, died suddenly May 25 at the age of 35.

At the time of his death Mr. Lyman was Head Structural Engineer of the Bureau of Aeronautics, in which position he had overall responsibility for planning, directing, and coordinating research in aircraft structural design and in formulating and administering structural design requirements for Naval aircraft. He had been with the Bureau of Aeronautics since 1940.

Born in Holly, Mich., July 9, 1913, he took his engineering education at the Carnegie Institute of Technology, where he received a Bachelor's degree in 1934 and a Master's degree in 1935.

Upon graduation he became associated with the Curtiss Aeroplane & Motor Company until 1936, when he resigned to become a design and test engineer at the Naval Aircraft Factory in Philadelphia. He remained at the Naval Aircraft Factory until his appointment with the Bureau of Aeronautics in 1940.

While at the Factory he was prominent in the development of equipment for vibration, acceleration, and strain measurements and was responsible for the dynamic testing of Naval aircraft.

At the close of his life, Charles Lyman was widely known throughout the aeronautical engineering profession as one of the country's outstanding specialists in aircraft structural design. He was a member of several A.N.C. and N.A.C.A. committees and rendered outstanding service during the war in this capacity. He was prominent in the formulation of ANC-1, ANC-1 (2), ANC-2, ANC-5, and ANC-18, all documents issued by the Army-Navy Civil Committee on Aircraft Design Criteria and universally used by the aircraft industry design. He also was a member of the N.A.C.A. Subcommittee on Aircraft Structural Design and the N.A.C.A. Subcommittee on Aircraft Loads.

A member of the Institute of the Aeronautical Sciences, Mr. Lyman throughout the war gave himself unstintingly in the solution of problems that arose in the structural design of Naval aircraft, and his ability, leadership, and high personal qualities became well known during that period.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Brown, William Byron, Ph.D., Aero. Research Scientist VI, Turbine Cooling Branch, Flight Propulsion Research Lab., N.A.C.A.

Lonnquest, Theodore Clayton, M.S., Rear Adm., U.S.N., Asst. Chief of Bureau of Aeronautics for Research and Development, U.S.N.

West, H. Oliver, President and General Manager, Canadair, Ltd.

Transferred to Associate Fellow Grade

McClarren, Ralph H., Ae.E., Director, Electronics & Instruments Div., The Franklin Institute Labs. for Research & Development; Assoc. Director in Charge of Aviation, The Franklin Institute.

Smull, Thomas Leland Kemp, B.S. in Ae.E., Head, Research Coordination, N.A.C.A. (Washington, D.C.).

Steinbacher, Franz R., M.S., Prof. & Dept. Head, University of Alabama.

Elected to MEMBER Grade

Anderson, William B., B.S. in E.E., Manager, Aviation Gas Turbine Div., Westinghouse Electric Corp.

Bradham, Robert Walker, M.E. (Aero.), Design Specialist (Power Plant), The Glenn L. Martin Co.

Cheilek, Harold A., B.S. in E.E., Head, Applied Mechanics Section, Cornell Aero. Lab.

Davis, Leighton Ira, M.S., Col., Chief Research Section, Engineering Div. A.M.C., U.S.A.F. (Wright Field).

DeWeese, Joseph Carroll, Operations Group Head, Power Plant Design Section, The Glenn L. Martin Co.

Edmunds, Edward, Jr., S.B. in C.E., Project Engineer, Davison Chemical Corp.

Hackett, Vincent, B.S.E.E., Field Engineer, General Electric Co.

Hinz, Earl Robert, M.S., Assist. Scientist, University of Minnesota.

Karaffa, Nicholas Thomas, B.S. in M.E., Engineer, Layout & Design of Equipment, Chase Aircraft Co., Inc.

Kenyon, Walter Clifford, Jr., B.S. in M.E., Aero. Research Scientist, Langley Mem. Aero. Lab., N.A.C.A.

Kidd, James Milton, Design Specialist, The Glenn L. Martin Co.

Kimball, Vernon Ross, E.E., Senior Engineer, Eclipse-Pioneer Div., Bendix Aviation Corp.

Kuhlman, William Herman, Jr., B.S. in M.E., Aerodynamicist, Douglas Aircraft Co., Inc.

Lee, Robert Elwood, B.S.

Moller, Marx Dietrich, B.S., Senior Stress Analyst, Wing Group, The Glenn L. Martin Co.

Pickard, Nicholas G., B.S., Engineering Test Pilot, North American Aviation, Inc.

Poggi, Martin Joseph, B.Sc., Installation Engineer, Airsupply Co.

Schroeder, Robert W., B.M.E., Chief, Power Plant Design Section, The Glenn L. Martin Co.

Snyder, Robert Orville, Power Plant Design Engineer, The Glenn L. Martin Co.

Stewart, Donald Stanley, B.E., Technical Superintendent, Australian National Airways Pty., Ltd.

Thornton, Kirby Fairfield, B.S. in M.E., Head, Aircraft Section, Development Div., Aluminum Co. of America.

Trich, Henry Chess, Chief Engineer, Saval, Inc.

Turner, William Robert, Operations Manager, The Glenn L. Martin Co.

von Stackelberg, Y. Zilberg, M.E., Design Specialist Engineer, Mechanical Design Section, The Glenn L. Martin Co.

Walker, William Allan, B.S. in Ae.E., Capt., Supervisor, Power Plant Section, Muroc Air Force Base, U.S.A.F.

Welborn, Max, B.S., Capt., U.S.N.R.; Bureau of Aeronautics Representative at The Glenn L. Martin Co. & Fairchild Aircraft Div. (Md.), Bureau of Aeronautics, Navy Dept.

Wohler, Stanley Alfred, Designer, Rotawings Div., The Glenn L. Martin Co.

Yasecko, Joseph S., B.A., Aero. Engineer & Consultant, Helicopter Development, A.M.C. (Wright Field).

Transferred to MEMBER Grade

Ahrens, Donald James, B.S. in Ae.E., Senior Stress Analyst, Cessna Aircraft Co.

Asher, Norman John, B.S. in Ae.E., Chief Engineer, Air Div., Naviera Colombiana (Colombia, S.A.).

Boley, Bruno Adrian, Dr. of Ae.E., Asst. Director of Structural Research Dept. of Aero. Engineering, Polytechnic Institute of Brooklyn.

Boykin, James Arthur, Jr., B.S.M.E., Asst. Chief, Bombardment Branch, Engineering Div., U.S.A.F.

Brewster, James Henry, III, B.S. in Ae.E., Asst. to the Vice-President, Fairchild Engine & Airplane Corp.

Kleber, John A., B.S. in M.E., Sr. Research Aerodynamicist, Cornell Aero. Lab.

Nicas, John Andrew, Interior Accommodations Engineer, Trans-Canada Air Lines (Canada).

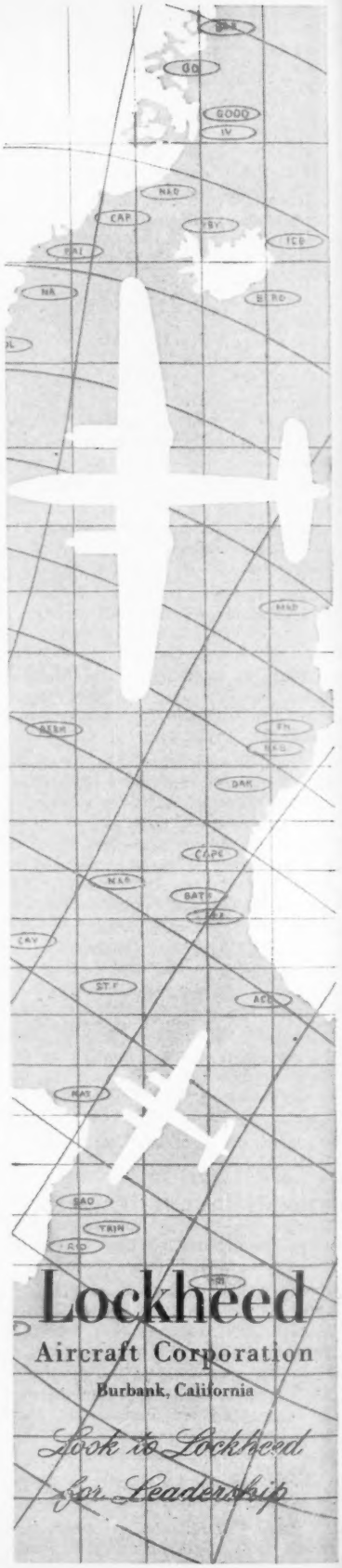
Elected to Associate Member Grade

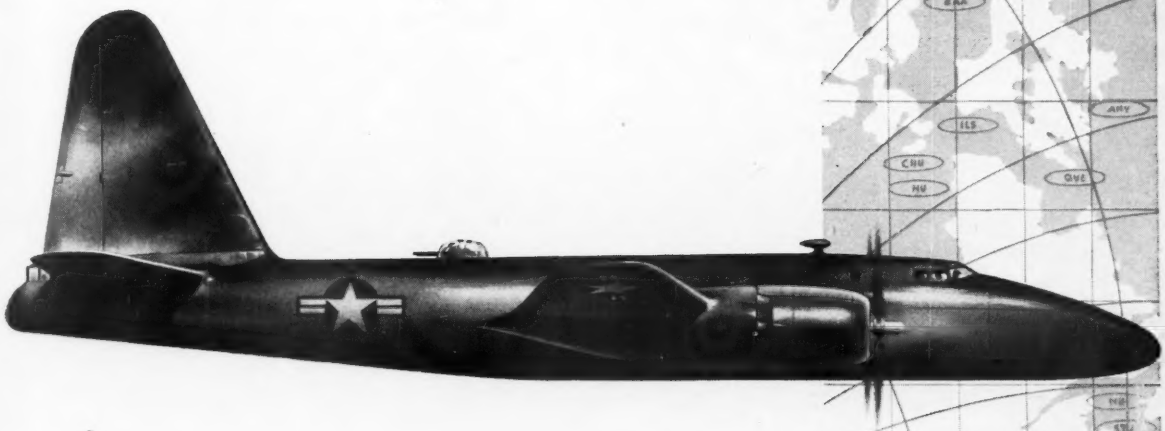
Echevarria, Fred, Buyer—Ground & Special Equipment, American Airlines, Inc.

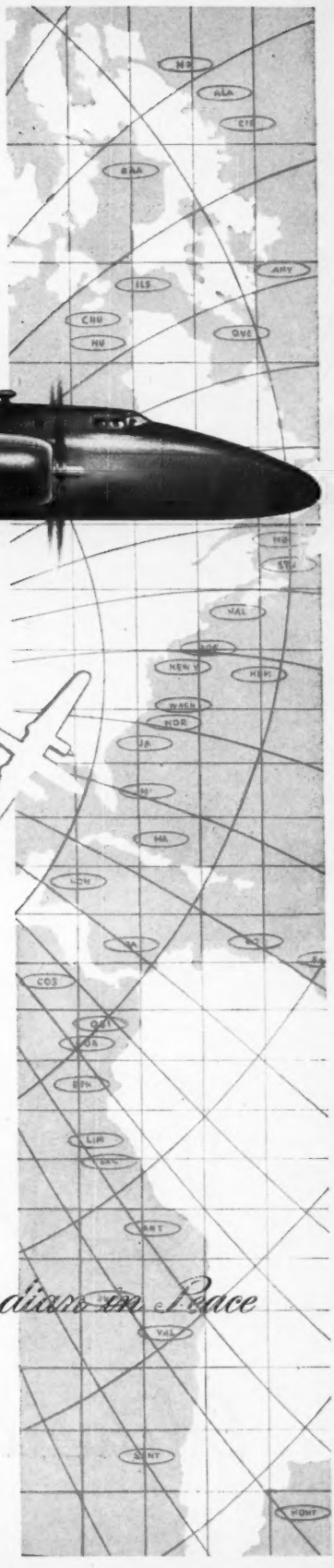
Shamie, Raymond, Sales Manager, Nathan Aircraft Devices, Inc.

Wanta, Raymond C., B.S., Research Meteorologist, Brookhaven National Lab., U.S. Weather Bureau.

(*Continued on page 89*)







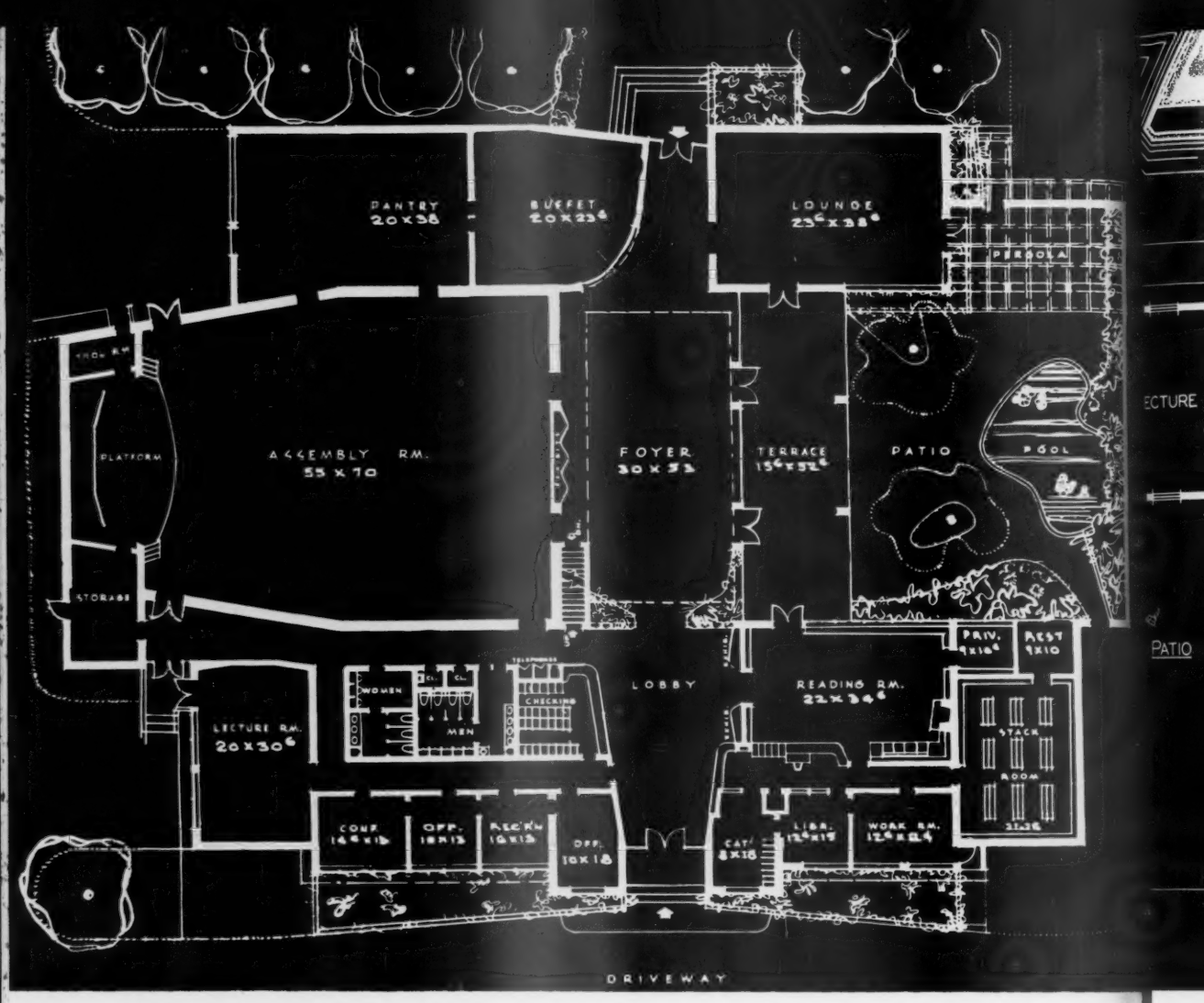
A Navy Champion

The Lockheed P2V Patrol Bomber

In its fleet of Lockheed P2V Patrol Bombers, the U.S. Navy possesses the longest-range aircraft in the world.* The Lockheed P2V gives the Navy long-distance sight and security — tireless, swift, reliable. Lockheed Aircraft Corporation, builder of the Navy's P2V, takes the occasion of Navy Day, October 27, to salute the men of the Navy on sea, on land, and in the air.

Your Navy—Victor in War, Guardian in Peace

*The U. S. Navy, flying a Lockheed P2V Patrol Bomber, holds the world's official record for nonstop long-distance flight — 11,236 miles.

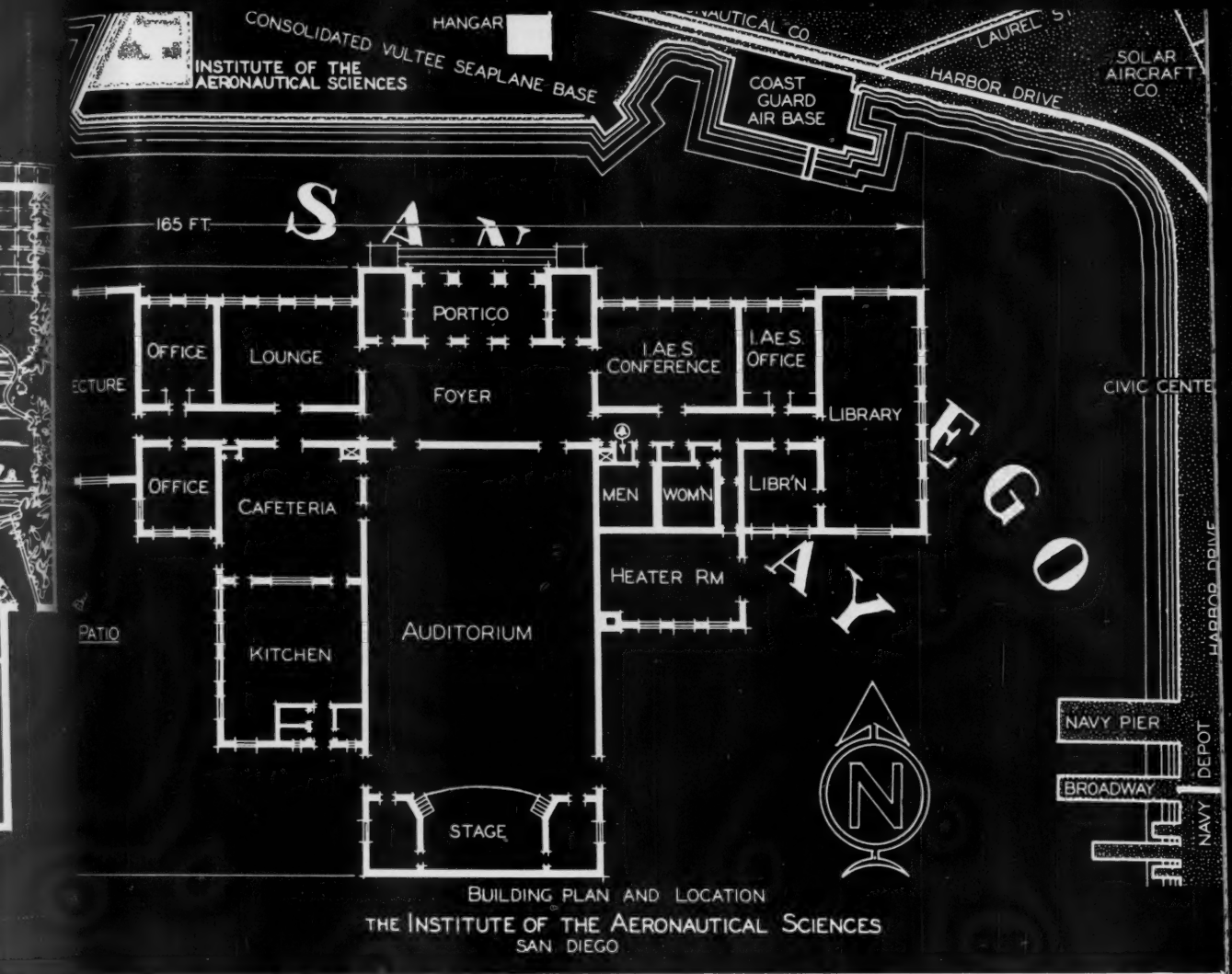


Editorial

At Long Last—

—and after lo, these many years, the gleam-in-the-eye is about to become reality. The papers have been signed, sealed, and delivered. The sites have been cleared, and, as the presses roll out this issue of the REVIEW, materials are being delivered and construction started on the Institute's new buildings in Los Angeles and in San Diego.

This happy culmination of the foresight and planning by Past-President Reuben H. Fleet and the other officers of the Institute (past and present) has come about from the persistence and hard work of the I.A.S. Building Committees in the two western cities. In spite of unstable material costs, uncertain labor conditions, and a host of other problems that made "Mr. Blanding's Dream House" practically a kindergarten



BUILDING PLAN AND LOCATION
THE INSTITUTE OF THE AERONAUTICAL SCIENCES
SAN DIEGO

exercise by comparison, these tireless workers in Institute vineyards made such persuasive presentations to our Council that permission to proceed followed "as the night, the day."

Now that the die has been cast, every member of the Institute may well take pride in the thought that, with the completion of these two new facilities in the West, together with our New York Headquarters, we will possess the finest physical plant of any of the professional societies. The Institute is the only society that can thus maintain adequate member-servicing facilities, including its own technical libraries on both Atlantic and Pacific seaboards.

But the mere possession of physical plants is not enough. The uses to which they are put and the quality of the support that is given to the activities that they house must be the final criteria. The management of the Institute, with the help of the local sections, is pledged to maintain these buildings and to plan for their proper utilization. We will do our part to the limit of our abilities. The rest is up to you—the members of the Institute. Through intelligent and continuous use of all your buildings you will get the most out of your membership. They are here to serve you. Make them your headquarters when your business takes you near them. Meet your friends there. Call on any of the Institute staff any time if we can assist you. That is part of our job.

We must all do our utmost to make an unqualified success of the program of expanding services on which we have embarked.

S.P.J.

Flight Handling Characteristics of a Modern Transport Airplane

A Symposium

By

SCOTT FLOWER
MELVIN GOUGH
RAYMOND B. MALOY
G. S. TRUMBLE, JR.

Under the Chairmanship of
R. D. Kelly
Superintendent of Engineering Development United Air Lines, Inc.

Symposium Panel: *Scott Flower, Pan American World Airways System; Raymond B. Maloy, Flight Engineering Division, C.A.A.; Melvin N. Gough, Chief Flight Research Division, Langley Memorial Aeronautical Laboratory, National Advisory Committee for Aeronautics; George Trimble, Jr., Chief Aerodynamicist, The Glenn L. Martin Company; and Raymond D. Kelly (Chairman), Supt. of Engineering Development for United Airlines, Inc.*

The following four papers formed the basis for a lively symposium and interesting discussion at the Institute's Sixteenth Annual Meeting, January 26–29, 1948. While it has been found impractical to publish the entire proceedings in this magazine, the original papers presented by the Symposium Panel Members are herewith published in full.—EDITOR.

Scott Flower
Pan American World Airways, Inc.

(1) INTRODUCTION

THE SUBJECT UNDER DISCUSSION—namely, flight handling characteristics—is dear to my heart for numerous reasons, the greatest of which is probably the fact that I am one of a group of Pan American Airways' pilots who has been exposed to more types of aircraft and their varied characteristics in scheduled operations than most pilots. The reason for this is found in the far-flung routes of the Company and the different aircraft needed for its varied operations. At one stage of our career, we were qualified simultaneously on the following aircraft: Sikorsky S-38, S-40, S-41, S-42, and S-43; Consolidated Commodore; and Douglas DC-3. This is quite a conglomeration of flying machines, each with its own peculiarities and flight handling characteristics.

Because of the varied characteristics of these aircraft and others that I have flown, I became interested in the why's and wherefore's of control and flight characteristics—particularly control loads.

In 1935, Pan American received its first Martin M-130 flying boat of the China Clipper class (more endearingly called the "China Chipper" because of its vibration characteristics, which, incidentally, the industry to date has done little to correct in modern transport). This flying boat had extremely heavy control forces, and, as a consequence, its flight characteristics were compromised. We have been criticized at times for not placing our transpacific operations on a 24-hour basis sooner than we did. I'll let you in on a secret; we couldn't! Because after 10 to 12 hours of flying the M-130, a stop was necessary to revive the crew! Mr. Trimble's coverage of his subject certainly shows that the Martin company has learned a great deal since those days, and the present Martin 202 is one of the best flying aircraft in the industry today—from actual pilot reports.

Because of our experience with the M-130, Harold Gray of our company became intensely interested in the subject of control loads and flight characteristics and, as a result, came up with a set of commendable criteria which was one of the first—if not the very first—

attempts in the industry to express in engineering terms those characteristics that a good flying airplane should have. Some later craft reflected the fruits of his efforts, but they had their weaknesses too; and today's operating requirements have changed considerably from those of 1935 through 1939 and therefore outmode some of his thinking.

(2) Criteria

During the war, a few of us had an opportunity to accomplish ILS and GCA approaches with Army equipment on such aircraft as the C-54 and C-87. It became evident at that time that, with the advent of precision methods for low approaches where ceilings would be reduced to 200 ft. and visilibity to $^1/_2$ mile, heavier demands would be placed on pilots which would require the aircraft to be maneuvered more readily and with greater ease than heretofore. The aircraft must be readily controllable with one hand from take-off through landing for these approaches, and response of the aircraft to the pilot's manipulation of the controls must be smooth and exactly what he anticipates. The ability of the pilot to control his aircraft easily with one hand throughout its régimes of take-off, climb, cruising, descent, and landing is necessary for safe operation of modern transport. This requirement is essential to allow the pilot use of his free hand for the operation of engine, flap, landing gear, and radio controls, as well as for other essential duties. Cockpits must also be designed to take advantage of the utility of the free hand by placing important controls within easy reach of the pilot and, if possible, within his field of vision when he is concentrating on the flight instruments.

With the foregoing in mind, the following requirements and flight characteristics over and above Civil Air Regulations Part 04 are considered desirable for ease of control and handling under various power combinations, as well as to minimize the effects of change in thrust, lift, drag, and balance upon control forces or trim. Also, an attempt has been made herein to clarify the statement in Part 04 which reads: ".....without requiring an exceptional degree of skill, alertness, or strength on the part of the pilot," in terms that will aid the designers of aircraft. Listed with these criteria are three modern aircraft of different manufacture: one two-engined (Aircraft A) and two four-engined (Aircraft B and C) to show how these airplanes measure up to the requirements.

It must be pointed out that these are desired control criteria from a pilot's point of view and, in the final design of a transport aircraft, are subject to compromise to acquire a well-rounded performance in all régimes and configurations of flight.

While these criteria have been discussed with several manufacturers from time to time, they will most certainly be exasperated to learn that some of the "numbers" expressed here tonight have been revised. However, after a 2-year lapse in time and the manufacturer's accomplishments to date, I believe that the revisions are sound.

(1) Effort to maintain trim during retraction or extension of wing flaps and/or landing gear in normal take-off or landing sequence—control forces:

	Desired	Maximum	Actual
	0	10 lbs.	
Aircraft A			10 lbs.
Aircraft B			18 lbs.
Aircraft C			16 lbs.

Reason: This keeps the pilot from concentrating on catching trim changes during critical stages of flight, such as landings and take-offs, when it is necessary for him to be concentrating on more important items. Also, the zero trim change adds to passenger comfort.

(2) Effort to maintain longitudinal trim while changing from one power setting to another (all engines operating) either in the take-off or the landing sequence —control force:

	Desired	Maximum	Actual
	0	15 lbs.	
Aircraft A			20 lbs.
Aircraft B			30 lbs.
Aircraft C			20 lbs.

Reason: The 15-lb. maximum force allows the pilot to correct easily for trim by stick force solely, without using the trim tab, keeping his right hand free for more important duties.

(3) Effort to maintain trim during flap and gear retraction or extension simultaneously with changes of power—in the take-off, land, or go-around condition. Control force at wheel:

	Desired	Maximum	Actual
	0	15 lbs.	
Aircraft A			15 lbs.
Aircraft B			15 lbs.
Aircraft C			15 lbs.

Reason: The 15-lb. maximum force allows the pilot to correct easily for trim by stick force solely, without using the trim tab, keeping his right hand free for more important duties.

(4) The most severe effect of flap extension or retraction or the most severe effect of power at any speed without structural limits shall not cause a control wheel force greater than 30 lbs. (push or pull).

Reason: This is a safety item that will allow the pilot ease of control in an emergency situation without the use of the trim tab.

(5) Control wheel travel for full aileron deflection:

	Desired	Maximum	Actual
	±120°	±135°	
Aircraft A			120°
Aircraft B			135°
Aircraft C			125°

Reason: This requirement allows full aileron deflection from one extreme to the other without changing

hand grip on the wheel. (Particularly important in turbulent air near the ground.)

(6) Elevator friction—final stabilized speed upon releasing wheel after displacing trim speed ±10 m.p.h. solely by stick force (air-craft trimmed at cruise speed for maximum range with c.g. in mid position). Variation from original trim speed:

	Desired	Maximum	Actual
	0	±2 m.p.h.	
Aircraft A			−2 m.p.h.
Aircraft B			−4 m.p.h.
Aircraft C			−3 m.p.h.

Reason: This assures adequate centering qualities of the elevator, allowing it to return closely to the trim position which ensures low friction and adequate control feel of the aerodynamic forces. Also keeps the pilot from continually "fiddling" to keep the aircraft flying level.

(7) Elevator control force to land aircraft trimmed for flight at final approach speed and configuration ($1.2V_{S0}$)—c.g. in mid position:

	Desired	Maximum	Actual
	25 lbs. (or less)	35 lbs.	
Aircraft A			20 lbs.
Aircraft B			35 lbs.
Aircraft C			36 lbs.

Reason: This requirement assures ease of control in landing, for the forces specified are approximately 40 to 50 per cent of pilot capabilities, thus allowing him to control power, etc., throughout the landing with his right hand. This is extremely important when executing landings in poor weather conditions.

(8) Elevator control force to land aircraft trimmed for initial approach speed ($1.6V_{S0}$) and configuration, changing to landing configuration without changing trim—c.g. in the most forward position, touch-down speed being that normally used—control force at wheel:

	Desired	Maximum	Actual
	40 lbs. (or less)	50 lbs.	
Aircraft A			80 lbs. (estimated)
Aircraft B			50 lbs.
Aircraft C			54 lbs.

Reason: This allows a pilot to land out of an initial approach without retrimming the aircraft for final approach speed. Again, extremely desirable for poor weather landings.

(9) Elevator effectiveness with power off—airplane trimmed for $1.2N_{S0}$ in most forward c.g. position, without the use of brakes—the effort necessary to hold the nose wheel off the runway in landing configuration at $0.7V_{S0}$ should be—control force at wheel:

	Desired	Maximum	Actual
	50 lbs. (or less)	60 lbs.	
Aircraft A			65 lbs. at 78 m.p.h.
Aircraft B			60 lbs. at 70 m.p.h.
Aircraft C			65 lbs. at...

Reason: This allows the pilot to hold the nose wheel off the runway with one hand and maintain the other one free for a "go-around" if necessary. Desirable for operations on rough runways and steel mats, besides cutting down on nose-wheel maintenance. If this requirement is met, then undoubtedly items 7 and 8 can be met.

(10a) Effort to hold aircraft in a 45° banded steady, continuous turn at maximum cruising power—control force at wheel (pull):

	Minimum	Maximum	Actual
	18 lbs.	30 lbs.	
Aircraft A			19 lbs.
Aircraft B			28 lbs.
Aircraft C			36 lbs.

Reason: This will allow 45° banded turns without using two hands on the control wheel and is a must for an emergency situation and for circling under an overcast to stay "close in" to a field.

(10b) Gradient of elevator control force in pounds per *g* as measured in steady, turning flight:

	Minimum	Maximum	Actual
	30 lbs. per *g*	50 lbs. per *g*	
Aircraft A			32.4 lbs.
Aircraft B			47.7 lbs.
Aircraft C			45.0 lbs.

Reason: This gradient assures that the minimum turning radius may be readily attained. The 30 lbs. per *g* minimum limit is to ensure against overloading the structure.

(10c) Steady pull force to attain allowable load factor:

Minimum	Actual
120 lbs.	....

Reason: This load is approximately twice that which can be attained with one hand and is a minimum for protection to the structure.

(11) Gradient of elevator control force per *g* in quick pullups. Should never be less than in steady turning flight under the same conditions of gross weight, configuration, altitude, c.g. position and air speed.

Reason: This assures no lessening of control loads in "quick pullups" which might overload the structure. In other words, the control feel is the same as in normal flight attitudes.

(12) With the aircraft trimmed at a cruising speed for maximum range, the aileron forces should always be great enough, when the aileron control is displaced ±30° and released, to return the control to trim position within ±2°:

	Desired	Maximum	Actual
	0	±2°	
Aircraft A			Unsatisfactory 0°
Aircraft B			Satisfactory
Aircraft C			However, can be improved

Reason: This requirement obtains self-centering characteristics of the ailerons, which is necessary for adequate control feel. Also keeps the pilot from continually working the ailerons to maintain lateral trim.

(13) Rolling criteria $pb/2V$ where p=rad. per sec; b=wing span, ft.; and V=air speed, ft. per sec. obtained from maximum rolling velocity at final approach speed and configuration through use of ailerons only:

	Desired	Minimum	Actual
	0.08 (or greater)	0.075	
Aircraft A			0.075
Aircraft B			0.068
Aircraft C			0.082

Reason: This requirement assures adequacy of lateral control at slow speeds and is necessary for approaches in turbulent air.

(14) Time to attain maximum rolling acceleration from steady straight flight with ailerons fully deflected. Time (from instant ailerons reach maximum deflection):

	Desired	Minimum	Actual
	0.20 sec.	0.22 sec.	
Aircraft A			Appears satisfactory
Aircraft B			Appears satisfactory
Aircraft C			Appears satisfactory

Reason: This requirement eliminates controls that are unsatisfactory from the standpoint of lag in developing the rolling moment. It appears that modern transports meet this requirement satisfactorily.

(15) Effort necessary to roll airplane with one hand —aircraft in a clean configuration, at all indicated speeds at and below $0.8V_{max.}$ (level flight speed) for the value of $pb/2V$ specified above—control force at wheel rim:

	Maximum	Actual
	40 lbs.	
Aircraft A		35 lbs.
Aircraft B		....
Aircraft C		50 lbs.

Reason: This requirement is to assure control loads that can be handled with one hand. This figure is approximately the maximum load that can be so attained.

(16) Effort necessary with one hand for full aileron deflection in final approach configuration at approach speed—control force at wheel rim:

	Maximum	Actual
	25 lbs.	
Aircraft A		30 lbs.
Aircraft B		45 lbs.
Aircraft C		26 lbs.

Reason: To obtain control loads easily handled with one hand in the final approach so that lateral trim may be maintained readily during turbulent air approaches.

(17) Effort necessary to hold wings level with one hand in take-off configuration, airplane trimmed for symmetric take-off power, with most critical engine inoperative and all other engines at take-off power—control force at wheel trim:

	Maximum	Actual
	30 lbs.	
Aircraft A		35 lbs.
Aircraft B		70 lbs. (full deflection)
Aircraft C		20 lbs. (75 per cent deflection)

Reason: Under emergency conditions, the aircraft can be controlled with one hand easily, thereby allowing the free hand to be used for other imperative duties.

(18) Rudder friction—variation from zero yaw when rudder is deflected to maximum position permissible and released slowly while holding aircraft level with aileron (aircraft trimmed at the initial approach speed and configuration)—change in yaw:

	Desired	Maximum	Actual
	0	±3°	
Aircraft A			±2°
Aircraft B			Not checked
Aircraft C			±2°

Reason: This requirement obtains good centering characteristics of the rudder, which is desirable from a control feel point of view.

(19) Effort necessary to maintain straight flight with trim tabs neutral, most critical engine inoperative at minimum control speed (V_{mc}) and all other engines at take-off power—force at rudder pedal:

	Desired	Maximum	Actual
	120 lbs. (or less)	140 lbs.	
Aircraft A			132 lbs.
Aircraft B			140 lbs.
Aircraft C			180 lbs.

Reason: The 180-C.A.A. limit is about 90 per cent of a pilot's capabilities and should be much less so that he can readily control the aircraft without relying on trim devices during the early stages of an emergency.

With the advent of jet-powered transports, I see no reason to relax any of the above criteria. As a matter of fact, it appears that certain of them might be tightened considerably.

(3) Conclusion

The accomplishment of the requirements listed above is within the realm of good design, and, as indicated, many of the newer aircraft are capable of meeting the majority of the criteria expressed. Pilots who have flown these new aircraft agree that they have superior flying characteristics over those of older design.

It is therefore to be anticipated that any future transport aircraft can and will meet these requirements.

Melvin N. Gough
Chief, Flight Research Division, Langley Memorial Laboratory, N.A.C.A.

Introduction

The existing good flying and handling qualities of modern transport airplanes are not just happenstance! They are the result of great effort on the part of designers, regulating agencies, and operators. They are also the result of the use of a vast amount of fundamental data accumulated by research and testing agencies augmented by opinions and desires of *many* pilots. The existence and application of this fund of knowledge is only now receiving widespread publication. Most of it was obtained prior to, and during, the war years. Although well known to many designers and test pilots who were actively engaged in this work during the war period, there are probably many engineers, pilots, operators, students, and others interested in Air Transport who would be more interested in the general picture covering the subject of flying qualities than any specific detail comments I might advance. As your interests direct, you may find it desirable to look into certain phases of the subject in more detail, in which case the references will be found most helpful.

This presentation, therefore, is directed primarily toward stating the existence of important available literature; tracing briefly the development by research methods of the fundamentals of flying and handling qualities requirements; establishing systematic testing techniques; and collecting, analyzing, and applying the resulting data. A few pertinent remarks and personal points of view regarding present large airplane flight characteristics will be presented for discussion.

Origin and Development of Flying Qualities Requirements

In 1936 in connection with the proposed design of a then extremely large transport airplane, an attempt was made by the major air lines to formulate a list of requirements for satisfactory flying and handling qualities in terms of the pilot's control forces and the airplane response in certain flight conditions and maneuvers. The problems of obtaining desirable, safe flying characteristics were known to become much more difficult as airplanes were made larger, heavier, and faster, because the effort available on the part of the pilot for operating the controls remained the same, whereas, the forces required on the airplane to steer and maneuver it increased tremendously. For the development of a new airplane, however, there was no known reliable procedure to provide for satisfactory flying qualities in the original design. It was realized that the main quantities influencing the pilot's opinions of an airplane must be the control forces and motions. But little was known about what characteristics of an airplane constituted satisfactory flying qualities. This does not mean that there had been no research on the subject of airplane stability. A great deal of theoretical work on this subject had been done. This theoretical work, however, was not able to take into account the characteristics of the human pilot and his relation to the airplane.

Pilots had for many years expressed opinion with regard to the handling qualities of airplanes, and it was well known that in some cases their opinions conflicted with the results of the theory. Generally, it was necessary for a series of trial-and-error changes to be made in test flights until the test pilot was satisfied with the qualities of the new airplane. The success of this procedure was a big gamble, depended on the skill of the pilot, and, of course, unfortunately provided little basis for avoiding poor characteristics in future designs.

Early agreement was reached that by the flying qualities of an airplane was meant those stability and control characteristics that have an important bearing on the safety of flight and on the pilot's impressions of the ease of flying and maneuvering the airplane. It also became apparent that a great deal of information of both a quantitative and qualitative nature was required on the characteristics of existing airplanes before a reliable and reasonable set of requirements could be written.

This fundamental problem was undertaken by the N.A.C.A. A preliminary listing of believed important items was made, and a program was instituted to make quantitative measurements of those characteristics on a number of existing airplanes.

The flight program got under way early in 1937. (Standard airplane instruments were used in the first test, the results of which were reported in an NACA report by H. A. Soule.[1] All the information desired was not provided. The N.A.C.A. recording instrumentation, already developed through many years of research, was then used to obtain the quantitative data. The high degree of success achieved in this project in its early stages was no doubt due, in large measure, to the adaptability of the N.A.C.A. recording instrumentation to any airplane. These instruments—developed to record air speed, control positions, angular motion about the three airplane axes, and normal, lateral, and longitudinal accelerations—operate simultaneously and continuously and are synchronized with a timer.

The quantitative data of reference 1 were compared with the pilot's opinion of the airplane. The immediate result of this analysis was to change several previously held concepts with regard to flying qualities and to add others. A notable example was the inclusion of the effect of yaw on pitch, which led to the measurement of sideslip.

Flight tests were then conducted on 16 other airplanes made available through the assistance of the Army, Navy, and C.A.A. and ranging in size from light airplanes to the largest four-engined bombers. From the fund of information thus accumulated, it was then possible for the first time to prepare a set of requirements for satisfactory handling qualities defining the

airplane characteristics that had been demonstrated to be essential for reasonably safe, efficient operation in easily measurable yet fundamental terms. This was presented in an N.A.C.A. report,[2] providing the basic foundation for all further development and application. Nowexisted a reasonable method by which an airplane could be evaluated or desires expressed.

During the war the research was continued, particularly on military airplanes. The technique and facilities were also applied directly to the war effort. Complete flying qualities tests were conducted by the N.A C.A. on over 65 airplanes of all types. Specific airplane problems were investigated and peculiarities and undesirable characteristics were corrected. Foreign and enemy aircraft were evaluated. The Army and the Navy adopted the N.A.C.A. requirements in setting up their own detail specifications for service aircraft.[3,4] They, too, tested many airplanes to determine quantitatively the degree to which their desires and needs were realized. To aid other agencies and the flight-test organizations of the various military manufacturers, the Army and the N.A.C.A. collaborated in outlining detailed procedures and satisfactory methods that would ensure adequate flight tests, proper pilot technique, and form of data presentation.[5]

The C.A.A. in CAR 0.04[6] has found it helpful to apply similar methods in the regulations.

The war period was marked by great cooperative effort and extensive flight testing by many investigators. Hundreds of reports containing quantitative data on flying characteristics were produced. Similar work was being carried on in allied countries and, to a lesser extent, was known to be receiving attention in enemy countries. The knowledge gained in all these efforts serves greatly to strengthen and confirm the original N.A.C.A. requirements,[2] and a few minor changes have been necessary. The results of practically all the tests mentioned are now available in report form for the use of the commerical industry.

Other important research contributions are contained in references 7, 8, and 9. Reference 7 presents the general procedures for the estimation of flying qualities from wind-tunnel tests.

Here is another example of the value of the flying qualities research in aiding the development of better transport aircraft and in promoting safety in flight. Formerly, little attention was paid in wind-tunnel testing of new models to those factors that influence the pilot. This was so because no quantitative standards were available. Now, the wind-tunnel tests are so arranged and analyzed that it is possible to predict the control forces required on the part of the pilot to maneuver a large airplane and also to predict whether he may inadvertently put the airplane into an uncontrollable attitude.

The risk involved in the first flight of a large airplane is thus greatly decreased. Many such N.A.C.A. wind-tunnel reports on specific airplanes are available.

Reference 8 contains the requirements for the appreciation and determination of the hydrodynamic qualities of seaplanes. Reference 9 summarizes the results of research that has led to an improved understanding of the correlation between theoretical, flight, and wind-tunnel stability and control investigations. Designers should find it extremely useful as an aid in selecting or modifying an airplane configuration.

The existing good flying and handling qualities of modern transport airplanes are not just happenstance! Basic requirements are well established. Questionable characteristics can be examined in detail. There is strong evidence that, when an airplane meets the basic requirements, it is fairly certain it will be safe to fly and desirable from the pilot's standpoint. Design and development has been well done. The future is promising.

Research must continue and revisions to the requirements will undoubtedly be necessary. Operators, designers, and regulating agencies must surely be thinking in terms of higher speeds, high altitudes, heavier wing loadings, much larger airplanes, and, of course, safer operations with lower weather minimums.

General Discussion

An important result of the concentrated efforts on flying qualities is the improved cooperative understanding, particularly between engineer and test pilot. All tend to think in terms of the same general systematic procedure and to express their opinions in understandable quantitative or qualitative terms. Test pilots and engineers both appreciate the opportunity to obtain quantitative data.

The most important pilot's criticism of the flying qualities of the modern transport is "forces." Friction and control forces receive first loud acclaim, whether extremely low and acceptable or, as is usually the case, too high. The N.A.C.A. has suggested reasonable force magnitudes, regulating agencies specify their requirements, the pilot puts up with values exceeding both—and gripes.

Friction must be kept low. It causes a loss of "feel" or self-centering, masks control free stability (or lack of it), causes the pilot lots of uncertainty and work, and makes for an uncomfortable ride. The large airplane designer goes to great effort to avoid it and is surprisingly successful. A large airplane recently tested, had 12, 20, and 25 lbs. static friction in the ailerons, elevators, and rudder, respectively. It was pretty bad. Removing improperly aligned autopilot servos from the control cables reduced the friction forces to 2, 5, and 9 lbs., respectively. The statistical data on friction and acceptable control forces presented in reference 10 is based on a wide range of experience. Friction can and must be kept to a low value.

Regardless of the airplane size the control forces must be kept low. The pilot should be able to take care of trim changes and make turns with one hand.

Responsive, light ailerons are most desirable on any large airplane. Attempts should be made to better the requirements. "Responsive ailerons" means usable

$pb/2V$ of at least 0.07 obtained with little more than 80° to 90° of wheel travel. Light ailerons does not imply that there is not a lower limit—remember self-centering and no force reversals.

Elevator control forces and friction are also due criticism. Forces required for changes in trim are usually too great. Airplane configurations usually required in maneuvers close to the ground seem most important. The force per g required in steady turns is also usually way out of proportion. Reasonable F/g values also result in satisfactory forces in steady flight and small trim changes. The variation of F/g with c.g. travel from very heavy at forward C.G.S. to very light at rear C.G.S. can be dangerous to maneuverability on the one hand and to the structure on the other. Safety is really at stake, and only one hand may be available. Some form of boosters, or spring tabs, which are mechanically reliable, giving a control response in proportion to pilot's applied force, are bound to see lots of service. Lots of trouble is avoided if control surfaces are not so closely aerodynamically balanced.

Static longitudinal stability is usually found to be neutral to slightly unstable in some configurations. Neutral to positive stability is desired and less tiring in long flights. Inadvertent stalling in approach conditions must be guarded against. With all the discussion on forces, these comments on stability may be taken as meaning the control free condition. Control fixed instability, of course, just doesn't have any appeal.

A test procedure necessary in the early stages of the flights is to check dynamic longitudinal stability, short-period oscillations, by making slight abrupt elevator deflections at increasing speeds. Friction may hold the controls until a speed is reached where the oscillation is unstable. It could build up rapidly to dangerous accelerations. Poorly damped oscillations are usually associated with unsatisfactory control feel in quick maneuvers. Be sure to have the safety belt fastened.

Little will be said about stalling characteristics—maybe because they haven't changed much and corrective control has always been good. Surely much work could be done in this field at the higher wing loadings. In general, however, the stalling characteristics may be considered good on existing large transport aircraft. Too early stall warning is not desirable.

Good directional stability is always provocative of praise. Has any one ever flown with too much? If so, wasn't it because the ailerons and rudder were not good?

Rudder forces are heavy. The usual problem is that they are heavy, then have force reduction or even reversal at large angles. Some are too light near neutral. No oscillations can be tolerated. There should be some lower force gradient limit.

Maybe the way to take care of the asymmetric power problem is to design the airplane so that it takes care of itself. Use the rubber as a trim tab, maybe—but why should the pilot have it?

TABLE 1

Large Airplanes, Four Engines	A	B
Landing Approach Characteristics		
Span, ft.	117	141
Wing loading, lbs. per sq.ft.	41	67
Wheel control travel, aileron, deg.	105°	180°
Maximum aileron deflection, deg.	27°	36°
Friction in aileron system, lbs.	12(2)	10
Rudder travel available, deg.	34°	36°
Landing Approach Possibilities		
Landing approach speed, m.p.h.	120	130
Maximum aileron force, lbs.	85	65
Maximum $pb/2V$ available	0.070	0.065
Maximum rolling velocity available, deg. per sec.	12.0	10.1
Angle bank per deg. sideslip	0.64	0.35
Landing Approach Performance		
Maximum aileron force used, lbs.	35	35
Maximum aileron angle used, deg.	12°	16°
Maximum control travel used, deg.	48°	80°
Maximum rolling velocity obtained, deg. per sec.	5.7	3.9
Maximum $pb/2V$ used	0.033	0.026
Maximum bank angle reached, deg.	.....	5.7°
Maximum sideslip recorded, deg.	3°	4°
Maximum rudder used, deg.	12°	32°–34°
Pilots' remarks	Acceptable	Unsatisfactory

Friction excessive except with servos out on A. No self-centering. Difficult to keep B lined up with runway. Awkward with one hand to use more than 90° aileron control. Directional stability of both A and B good. Ailerons on B seem light.

It is suggested that a speed reducing device or drag brake could be used to advantage on our present high-speed, heavy transports. Placard limits can be too easily reached and rate of descent too limited. Maybe this problem can be cared for by the reversible propeller, so otherwise greatly needed.

Surely no one appreciates good flying qualities more than does the airplane pilot. Schedules and frequent operations near weather minimums are bound to affect one's opinion. Most exacting demands accompany breaking out at minimum conditions of ceiling and visibility, then circling the field trying to keep the airport and runway in view because a straight-in approach was not feasible.

Future operations may involve changes in operating technique as well as improvements of the airplane itself. The problem of the demands on stability and control imposed by the conditions of instrument approach and blind landing is being studied on existing airplanes. Obviously, increased size and approach speed will force changes in present operational practice.

An example of the type of problems encountered in this study is shown by data from representative portions of records taken during landing approaches of each of two large airplanes. These data are presented in Table 1. Pilots Airplane A acceptable, but excellent when control friction is reduced. Airplane B is flyable, airworthy if you will, but really unsatisfactory in view of the difficulty experienced in trying to keep lined up with a runway.

Comparing A and B, A requires greater force for full aileron travel, has less total aileron deflection available, has less control wheel travel, yet produces high rolling velocities!

The friction in the ailerons for Airplane A could be reduced from 12 to 2 lbs. The approach speed for A is 10 m.p.h. slower than for B. The side force for A, as shown by the angle of bank per degree sideslip, is nearly double that of B.

In both cases the pilot used an average maximum aileron force of 35 lbs. Although only approximately half of the available aileron control was used, the rolling velocity of A is higher than B. Far less rudder was used on A than on B. Although the aileron forces were the same and both quite a load for one hand, nearly twice the control wheel travel was required in B to obtain that force. The pilot does less work to keep A in the groove! It would appear that it could be flown safely to lower minimums.

Both airplanes are really flyable. Both have been pretty thoroughly tested by existing handling qualities requirements and were found to be reasonably satisfactory. Further study is required to explain the reason for difference in opinion. It appears from the above discussion that the factors affecting the problem are differences in side force characteristics and control wheel travel for a given rolling velocity. Refinement and extension of existing requirements will undoubtedly be necessary as such specific operational problems become more apparent.

The importance of good quantitative data in such problems is also apparent. Future operating practice and regulation policies are going to need much more fundamental research for their guidance. Fundamental research in this field continues. A most interesting future of research and design is implied for the large transport airplane.

References

[1] Soule, H. A., *Preliminary Investigation of the Flying Qualities of Airplanes*, N.A.C.A. T.R. No. 700, 1940.

[2] Gilruth, R. R., *Requirements for Satisfactory Flying Qualities of Airplanes*, N.A.C.A. T.R. No. 755, April, 1941.

[3] Anon, *Stability and Control Characteristics of Airplanes*, Army Air Force Specification No. R-1815-A, April, 1945.

[4] Anon., *Specification for Stability and Control Characteristics of Airplanes*, SR-119A, Navy Department, Bureau of Aeronautics, April, 1945.

[5] Army Air Forces, *Stability and Control Flight Test Methods*, A.A.F. T.R. No. 5242.

[6] Civil Aeronautics Manual 04, *Airplane Airworthiness*, revised July, 1944.

[7] Kayten, C. G., *Analysis of Wind-Tunnel Stability and Control Tests in Terms of Flying Qualities of Full-Scale Airplanes*, N.A.C.A. L-322, October, 1943.

[8] Parkinson, J. B., *Appreciation and Determination of the Hydrodynamic Qualities of Seaplanes*, N.A.C.A. T.N. No. 1290, May, 1947.

[9] Phillips, W. H., *Appreciation and Prediction of Flying Qualities*, N.A.C.A. (in process of publication).

[10] Abzug, M. J., *Flying Qualities Requirements for Military Aircraft*, Aeronautical Engineering Review, Vol. 5, No. 10, p. 16, October, 1946.

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Introduction

The first set of requirements applying exclusively to transport aircraft found their way into the Civil Air Regulations in May, 1940, with the adoption by the Civil Aeronautics Board of Amendment 56 to Part 04. This amendment made far reaching steps in the direction of relating the performance of the aircraft to the dimensions of the route over which it is flown. At the same time, the section of the regulations pertaining to the flight characteristics was also extensively revised. Subsequently, there have been various minor changes to this portion of the regulations, most recent of which were discussed in hearings before the Board in September, 1945. One of the more important changes made at that time was the elimination of the requirement for dynamic longitudinal stability with respect to the long-period oscillation. In addition, the hearings led to more specific requirements regarding longitudinal control, minimum controllability speed, and stall warning. At the present time the latest requirements of the C.A.B. and C.A.A. on the flight characteristics of transport type aircraft are contained in CAR 04b.13. These requirements form the basis for this paper.

Objectives of the CAR's

Before embarking upon a general outline of what our civil requirements consist, it is well to point out the fundamentally different approach to this problem which the C.A.A. must necessarily take as compared with the views held by a research organization or a purchasing agency such as an air line or the armed services. The C.A.A.'s primary concern is safety, and we are, therefore, constrained in our approach to the problem of flight characteristics. Other agencies are invariably searching for an ideal combination of flight characteristics which usually involves much more detailed and more comprehensive testing. It is important that this fact be made clear at the outset of any discussion of the Civil Air Regulations, since what might appear to be omissions in these requirements are in many cases merely omissions of detail rather than principle. The reason for this lies in the fact that specific requirements call for specific answers, and specific answers require detailed flight testing. The C.A.A. as the body administrating the Civil Air Regulations is constantly under pressure to keep to the absolute minimum the amount of instrumentation, flight testing, and data reduction in showing compliance with these requirements. As a direct result, the regulations have been written with as little emphasis as possible on quantitative testing and yet requiring qualitatively those attributes that pilots and engineers agree constitute minimum desirable handling characteristics.

Flight testing of a modern-day transport aircraft runs into considerable cost per hour, including insurance, ground and test crews, etc., and since the overall budget for production of a prototype has usually been exceeded by the time such an aircraft reaches the flight-test stage, there is great pressure to complete the job as expeditiously as possible and gain some return on the investment. It must also be remembered that the transport market is limited, and the cost of development of an airplane must be divided among the number sold. Therefore, the builder of such an airplane is, at the outset, only interested in showing that the airplane is safe. He is willing to delay proof of existence of qualities that are over and above the minimum required until they are demonstrated in service. Consequently, great emphasis is placed on preflight planning and programming to utilize to some useful purpose every minute spent in flight. To assist manufacturers in this work, various reports, based upon experience, have been prepared by the C.A.A. outlining in great detail the suggested order of testing, the instrumentation required, and the grouping of flights into the most convenient categories regarding configurations involving similar weight and c.g. positions. *Safety Regulation Release No. 252* contains information of this type together with interpretations of all other flight requirements for transport aircraft. At the present time, our records indicate that the amount of time required to evaluate the flight characteristics of a transport aircraft is approximately 10 to 15 hours out of a total flight-testing time of 30 to 40 hours required to show compliance with all the Civil Air Regulations. These figures are based upon the presentation of the aircraft to the C.A.A. in the correct configurations, center of gravities, and weights and without retesting being necessary. This is in considerable contrast to statements made by Von Baumhauer in 1939, in his paper before the Royal Aeronautical Society, to the effect that flight handling characteristics of an aircraft could adequately be determined in approximately 2 hours of flight testing.

The Present Requirements

The relation between flight characteristics and safety involves the level of skill, intensity of attention, and complexity of operation required on the part of the pilot to fly the airplane. It is possible to design an airplane that cannot be flown by a single pilot, because, for example, he may not have enough strength—or alternatively, a sufficiently delicate touch—to operate the controls, or there may be so many necessary operations that he cannot, within the required time, perform them all. The purpose of the flight requirements is to ensure that a pilot, or any appropriate crew, may operate the airplane with enough margin of ease of control that the performance of the airplane which has been covered by the other requirements may be realized and an additional reasonable measure of safety maintained.

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Engine Power
04.13101	Elevator Effectiveness	Demonstrate ability to pitch nose down rapidly between $1.4V_{S1}$ and V_{S1}	Max T.O. & Land.	Max. Aft	Up Dn	Dn	Off & max. cont.
04.13102 a(1),(7) (2)	Sudden changes in flaps	Extend flaps, retract flaps; measure control forces maintaining $1.4V_{S1}$	Max. Land.	Max. Fwd. & Aft	Up & Dn	Dn	Off & max. cont.
a(1),(2)	Sudden changes in power	Apply take-off power quickly while maintaining same airspeed	Max. Land.	Max. Fwd & Aft	Up & Dn	Dn	Variable
c	Variation in airspeed	Fly airplane with one hand from $1.1V_{S1}$ to $1.7V_{S1}$ or placard speed trimmed to $1.4V_{S1}$	Max. land.	Max. Fwd.	Dn	Dn	Power off
04.13103	Flap retraction	Demonstrate ability to retract flaps without losing altitude	Land.	Max. Fwd. & Aft	Land.	Dn	Power off to max. cont.
04.13100	Ground handling	Demonstrate control of attitude during T.O. ground roll	Max. T.O.	Max. Aft			
04.141	Ground handling	Demon. absence of nose over tendency in take-off, landing and ground oper. & of porpoising for seaplanes	Appropriate				

Fig. 1. Longitudinal control.

The succeeding material covers only the more important of the flight characteristics that have been agreed to be critical or representative flight régimes. The requirements will, in most cases, indicate the loading conditions considered to be critical, and, assuming the airplane to be in compliance with those requirements at the given loading conditions, no investigation of other loading conditions will ordinarily be required. If the airplane is unorthodox in any respect or presents problems not expected by these specific conditions, additional tests will be necessary to show that no unairworthy characteristics exist. If there is reason to believe that any of the flight characteristics are affected by altitude, they will be investigated for the most adverse altitude condition expected in normal operation.

The flight requirements, CAR 04b.13, are broken down into the following groups: Controllability (the functioning of the primary controls), Trim Control, Stability, and Stalls. Let us examine these individually. An outline of the tests for longitudinal control is shown in Fig. 1. Demonstration of the effectiveness of the elevators is required by their ability to control the attitude of the ship on the group and by their ability to provide moments to counteract effects of sudden flap or power changes and, in addition, without change of stick force greater than can be easily met for short periods with one hand. Mr. Flower mentioned this need in his portion of this symposium. The tests required are realistic in that change of flap positions,

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Engine Power
04.1312	Minimum Control Speed	Determine minimum control speed when engine is suddenly made inoperative	Max. T.O.	Max. Aft	T.O.	Up	T.O.
04.13110	20° banked turns	Demonstrate 20° banked turns with and against inoperative engine from steady climb at $1.4\ V_{S1}$	Max. T.O.	Max. Aft	Climb	Up and Dn.	Max. cont.
04.13111	Sudden changes in heading	Execute sudden changes in heading in either direction while holding the wings level	Max. Land.	Max. Aft	Appr.	Up	Power for level flight at $1.4\ V_{S1}$ but not more than max. cont.
04.13112	Sudden changes in heading	**Airplanes of 4 or more engines** Execute sudden changes in heading in either direction while holding the wings level with 2 critical engines cut.	Max. Land.	Max. Fwd.	Climb	Up	Power for level flight at $1.4\ V_{S1}$ but not more than max. cont.
04.142	Ground handling	Demonstrate directional stability and control during power-off landings, in cross winds and taxiing	Any	Any	Appr.	Dn	Appropriate
04.145		Demonstrate 3 take-offs and landings in critical cross winds.	T.O. and Land.	Max. Aft	T.O. and Land.	Dn	Take-off or power-off

Fig. 2. Lateral and directional control.

application of power, or change of air speed, etc., are those expected to be encountered in normal operation.

Tests for lateral and directional control power are shown in Fig. 2. The requirements constitute the ability to make 20° banked turns and sudden changes in heading against inoperative engines and the determination of a minimum control speed and a critical cross wind for take-off and landing. Requirements of the trim control system are reviewed in Fig. 3. The tests consist simply of demonstrations of ability to maintain trim for any flight condition that it is reasonable to assume will be maintained for any appreciable time. Longitudinal, lateral, and directional trim are required in level flight with all engines operating over a range of speeds normally expected. Longitudinal trim is required in a climb with all engines operating and in a glide with power off. Both of these are at a normally expected operating speed. Directional and lateral trim are required in level flight but are not required in climb and glide because these conditions are never critical. Finally, longitudinal and directional trim are required with one engine inoperative, and, on airplanes of four or more engines, trimmed rectilinear flight is required with two critical engines inoperative.

The static stability requirements are given specifically for the stick free condition. It will be noted that a great deal more attention is devoted to longitudinal stability than to lateral or directional stability. This, of course, is necessary because the longitudinal stability is more critical with changes of center of gravity and, therefore, usually determines the center of gravity limits. Establishment of a stable slope to the elevator stick force curve is required over an appropriate speed range for the configurations shown in Fig. 4. In addition, a pull must always be required down to the lowest steady speed in unstalled flight and a push up to the appropriate operating limit speed, even though the slope of the stick force versus air-speed curve is permitted to reverse. Maximum and minimum limits to the degree of stability are established roughly, on the high side, by specifying maximum permissible stick forces over certain speed ranges, and on the low side, by specifying that the air speed shall return to within 10 per cent of the original trim speed when the control force is slowly released at some other speed. The full significance of this minimum stability limitation can be seen easily by reference to Fig. 5. It is necessary that the slope of this curve (degree of stability) be sufficiently great so that the portion of the curve lying within the friction band does not extend further than plus or minus 10 per cent of the trim speed from the trim speed. In our opinion, it is most significant to indicate control system friction in these terms, since the width of the friction band and slope of the stick force curve indicate the amount of difficulty involved in maintaining trim speed. Stick free static stability and control feel near trim speed are ensured, since, if friction is high, the variation of stick force with speed must be correspondingly high. It is to be noted that the method of specifying a maximum stick friction on

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Engine Power
04.132a	Directional and lateral trim	Demonstrate trim from $1.4V_{S1}$ to 90% speed at max. cont. power in level flight or placard speed	Max. T.O.	Max. fwd. & aft	Up	Up & Dn	Power for level flight
04.132a (1)	Longitudinal trim in climb	Demonstrate trim at $1.4V_{S1}$	Max. T.O.	Max. fwd.	Up & T.O.	Up	Max. cont.
04.132a (2)	Longitudinal trim in glide	Demonstrate trim at $1.4V_{S1}$	Max. land.	Max. fwd.	Up & land.	Dn	Power off
04.132a (3)	Longitudinal trim in level flight	Demonstrate trim from $1.4V_{S1}$ to 90% speed at max. cont. power in level flight or placard speed	Max. T.O.	Max. fwd. & aft	Up	Up & Dn	Power for level flight
04.132a	Trim for 4 or more engine airplane—2 engines out	Demonstrate ability to maintain recti-linear flight at power and airspeed used in 04.1232	Max. land.	Max. fwd	Opt.	Up	Max. cont.
04.132c	Longitudinal & directional trim	Demonstrate trim at $1.4V_{S1}$ with critical engine out	Max. T.O.	Max. fwd.	Up	Up	Max. cont.

FIG. 3. Trim control.

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Engine Power
	Stick free static stability in:	Determine stick force from:					
04.13310a	Landing	Just above stall to $1.8V_{S1}$ or to placard speed trimmed at $1.4V_{S1}$	Max. land.	Max. fwd. & aft	Land.	Dn	Power off
04.13310a	Approach	Same as above	Max. land.	Max. aft	Appl.	Up	Power for level flight at $1.4V_{S1}$
04.13310c	Climb	85% to 115% of V_{TRIM}	Max. T.O.	Max. aft	Up	Up	75% Max. cont.
04.13310a (1)	Cruise	Just above stall to $1.8V_{S1}$ or to V_{MO} whichever is lesser	Max. T.O.	Max aft	Up	Up	75% Max. cont.
04.13310a (2)	Cruise	Same as above, but do not exceed level flight trim speed or gear down placard speed	Max. T.O.	Max. aft	Up	Dn	75% Max. cont. or for V_{LE}
04.1332	Dynamic Stability	Demonstrate damping of any short period oscillations between stalling speed and max. permissible speed. Stick fixed and free					

FIG. 4. Longitudinal stability.

the ground does not allow for the effects of structural changes and deformations due to altitude, speed, heating, or pressurization.

The accepted specification of stick fixed static stability—i.e., a negative slope of the curve of elevator angle versus speed—is not a specific part of our requirements. It is realized that the displacement of the longitudinal control should normally be forward for increasing speed and vice versa and should be approximately proportional to the departure from the trim speed produced. Nevertheless, it does not in itself seem unsafe to have to move the control stick rearward to slow down and then forward to a position ahead of the original position to hold the lower speed, assuming, of course, adequate down elevator is always available to prevent stalling.

If the airplane were so statically unstable stick fixed as to be obvious to the pilot, it would probably not

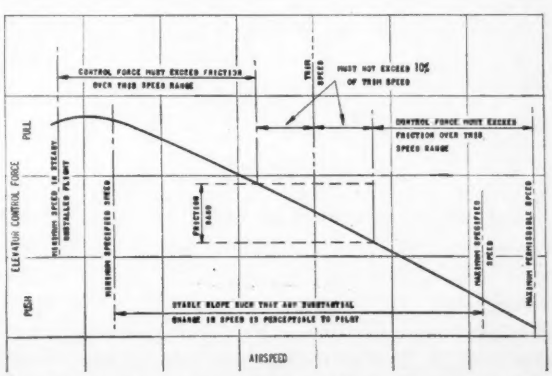
CONTROL FORCE MUST EXCEED FRICTION OVER THIS SPEED RANGE
TRIM SPEED
MUST NOT EXCEED 10% OF TRIM SPEED
CONTROL FORCE MUST EXCEED FRICTION OVER THIS SPEED RANGE
ELEVATOR CONTROL FORCE
PULL
PUSH
MINIMUM SPEED TO STEADY UNSTALLED FLIGHT
MINIMUM SPECIFIED SPEED
FRICTION BAND
MAXIMUM SPECIFIED SPEED
MAXIMUM PERMISSIBLE SPEED
STABLE SLOPE SUCH THAT ANY SUBSTANTIAL CHANGE IN SPEED IS PERCEPTIBLE TO PILOT
AIRSPEED

FIG. 5. Requirement for stick-free static longitudinal stability.

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Power
	Static Stability:						
04.1323a	Directional	Demonstrate recovery from skid with rudder free from $1.2V_{S1}$ to limit speed	Max. T.O. & Land.	Max. Aft	Up & Land.	Up & Dn	Power off & 75% max. cont.
04.1323b	Lateral	Demonstrate raising low wing in sideslip	Max. T.O. & Land.	Max. Aft	Up Land.	Up & Dn	Power off & 75% max. cont.
04.1323c	Directional and Lateral	Demonstrate proportionality of aileron and rudder deflections and forces during sideslip	Max. T.O. & Land.	Max. Aft	Up Land.	Up & Dn	Power off & 75% max. cont.
04.1323d	Short period dynamic directional and lateral stab.	Demonstrate damping of short period oscillations with controls free and fixed at all speeds.	Max. T.O. & Land.	Max. Aft	Up Land.	Up & Dn	Power off & 75% max. cont.

FIG. 6. Directional and lateral stability.

meet other airworthiness requirements; for example, the dynamic longitudinal stability requirement specifies that any short-period oscillation, stick fixed or free, must be heavily damped, thereby requiring good stick-fixed static characteristics. As mentioned previously, requirement of the damping of the phugoid motion has been eliminated from the regulations, because it has been shown that it has no bearing on safety of flight or desirable flying qualities

A résumé of the tests for directional and lateral stability is shown in Fig. 6. The tests are only qualitative, but static and dynamic stability are required both stick fixed and free. Recovery from a skid, raising the low wing in a sideslip, and proper proportionality of rudder and aileron movements and forces in a sideslip are required. Rudder force reversal is not permitted at angles up to that at which full rudder deflection is employed or a rudder force of 180 lbs. is needed, and increased yaw is also required with increased rudder angles up to full deflection.

The stall tests are primarily a demonstration to ensure that the first response of the airplane is downward pitching. The requirements specify that the aileron and rudder controls operate normally up to the instant of pitch and that, with unreversed use of these controls, a pilot must be able to produce and correct roll and yaw up to the time pitching is initiated. They also limit inadvertent roll after the pitch and before recovery and require a stall warning at a speed at least 5 per cent above the stalling speed. This stall warning may be furnished either through aerodynamic or other means. Although the warning must be present at a speed 5 per cent above the stalling speed, it should not be too violent or present to such an extent at normal operating speeds as to be dangerous to the fatigue life of the structure or worrisome to passengers. The required aircraft configurations are listed in Fig. 7.

Problems of Compliance

We have now covered the flight handling requirements, and I wish to discuss briefly some of the problems of complying with the regulations. As indicated previously, the longitudinal stability problem is a source of considerable difficulty. The problem is aggravated in transport type aircraft, because for economic and operational reasons it is desirable to stretch the c.g. range to the limit. Every conceivable means should be taken in the original design to ensure that the maximum possible aft c.g. of a design can be utilized. Provision should be made to preclude the possibility of elevator force or elevator area limiting the range of center of gravity. In addition, it should be remembered that control system friction is affected by speed, internal and external temperature, and pressure. The possible effects on allowable aft c.g. through the requirements shown in Fig. 5 should not be overlooked. An increase in friction requires an increase in the slope of the curve of elevator angle versus air speed, and thus higher stick forces in low-speed maneuvers and at forward c.g. will result. Some difficulties may be experienced in meeting the one-hand forces or the 80-lb. maximum allowed in the landing configuration.

Because of growth in aircraft size, it is to be expected that the control force problems will mount. The problems involved in attempting to balance control surfaces aerodynamically appear difficult, particularly for extremely large or high-speed aircraft. Because of manufacturing tolerances, it will probably be necessary to use means other than aerodynamic balances, such as power boost, to keep control forces within reason on large high-speed aircraft. Also, the effect of ice accumulations on the aerodynamic or mass balance is almost unpredictable.

Although much has been said in the past on the subject of vertical tail area, I believe it will bear considerable repetition. In my opinion, more difficulty than is realized in regard to lateral and directional stability can be eliminated by using adequate vertical tail area. Insufficient attention has been paid to the fact that, as an airplane slows down with unsymmetrical power, more and more aileron is needed to keep the wings level. Adequate tail area will alleviate this condition through reducing yaw. Consequently, the amount of aileron required and the resulting adverse aileron yaw are also reduced. Reduction of yaw will decrease the possibility of rudder lock, and the maneuvering vertical tail load structural problem will also become less critical. In addition, ability to hold wings level in approach to the stall will be improved. Extra vertical tail area should be provided where tail blanketing is a result of wing root stall so as not to cause a decrease in directional stability.

CAR No.	Test	Procedure	Wt.	C.G.	Flap	Gear	Power
04.114	Stalls Straight Flight	Demonstrate ability to correct roll and yaw up to time of stall by unreversed use of ailerons and rudder, and to prevent more than 20° of roll after stall using normal piloting skill.	Land.	Fwd.	Appr.	Dn	On
			Land.	Fwd.	Land.	Dn	On
			Land.	Aft	Appr.	Dn	Off
			Land.	Aft	Land.	Dn	Off
			Land.	Aft	Appr.	Up	On
			Land.	Aft	Appr.	Dn	On
			Land.	Aft	Land.	Up	On
			Land.	Aft	Land.	Dn	On
			T.O.	Aft	Up	Dn	Off
			T.O.	Aft	T.O.	Dn	Off
			T.O.	Aft	Up	Dn	On
			P.O.	Aft	T.O.	Dn	On
	Stalls in Turns	Demonstrate ability to correct roll and yaw up to type of stall by unreversed use of ailerons & rudder, in turns of 30° of bank	T.O.	Aft	Up	Up	Off
			T.O.	Aft	Up	Up	On
			Land.	Aft	Land.	Dn	Off
			Land.	Aft	Land.	Dn	On
04.1340	Stalls 1 Eng. out	Demonstrate whether airplane safely recoverable when stalled with crit. eng. out. Operating engines may be throttled back during recov. ry.	Max. T.O.	Max. Aft	Up	Up	75% Max. cont.

FIG. 7. Stalling.

In regard to stall characteristics, I have one suggestion with which most everyone is already familiar—that is, the desirability of insisting on a wing root stall that progresses forward instead of outboard in order to ensure pitching before rolling.

Conclusions

Although the Civil Air Regulations will inevitably fall short of producing the ideal airplane from a flight characteristic standpoint, a continuing effort should be made to improve these standards as the knowledge of the subject advances. As the speed and complexity of modern-day transport increase, every effort should be made to ease the burden on the pilot through improved handling characteristics. This philosophy will certainly increase greatly the overall standard of safety of air transportation.

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Introduction

The subject for discussion, "Flight Handling Characteristics," is an interesting one to me because it demonstrates clearly that the production of a satisfactory airplane is at least partially an art rather than completely a science. The need for an "artistic" approach to airplane design becomes especially evident when we attempt to define and design for desirable flight handling characteristics. As an engineer, I am extremely interested in this problem because it is complex and the tools available for the solution are somewhat inadequate. As a human being, I find it an engrossing problem because of the interrelation of human and engineering values necessary to a satisfactory solution. The following remarks relate for the most part to the Martin 202. I believe the subject, "Flight Handling Characteristics," can be divided into two main categories: first, those characteristics necessary for safe flying of the airplane; second, those characteristics necessary for good pilot acceptance. Admittedly, it is extremely difficult to pick any one flight characteristic and say that it definitely goes into one or the other of these categories. In general, I think it can be said that the flight characteristics having to do mainly with safety requirements can be defined fairly satisfactorily with numbers. Those flight characteristics that have to do chiefly with pilot acceptance we endeavor to define with engineering values, but, as might be expected, we are ofttimes unsuccessful.

The very factors that produce a high performance commercial airplane aggravate the flight handling characteristics problem immensely. First, the power effects on trim and stability are much greater with high-powered engines. Secondly, to acquire low stalling speeds and, hence, short landing and take-off distances, we must have extremely large and effective flaps which intensify the trimming and control force problems. To obtain the highest speeds for the least power, we use low drag type of wing and tail airfoils. Unfortunately, these airfoils sometimes have low maximum lift coefficients and poor stalling qualities. Finally, to be useful, a transport airplane must have an extensive permissible center of gravity movement that makes it difficult to obtain completely satisfactory control forces at both ends of the range.

In a few cases it is impossible to achieve a satisfactory solution to these problems without incorporating nonaerodynamic devices in the airplane.

Flight Handling Characteristics and Safety

The usual approach to this problem is made by first assuming possible emergencies that might arise during any flight of an airplane, then determining the handling characteristics that will permit the pilot to return the ship to a safe régime of flight without requiring that he have exceptional skill, or strength, or that he pay undue attention in taking corrective action. Some of these possible emergencies are engine failure at take-off or just before touch-down, balked landings, and inadvertent stalls both with and without power. It is our opinion that CAR 04b defines in a comprehensive manner the flight handling characteristics required for safe flight. To summarize just how these requirements affect the airplane design, I shall review them briefly.

Trimming Devices and Changes in Trim with Power and Flaps

Sufficient trim power must be available for all reasonable combinations of air speed and power with extreme center of gravity locations, partial engine conditions, and offset lateral loadings. This requirement pretty well determines the trim tab sizes for the airplane.

The use of extremely powerful high lift devices to obtain the desirable low stall speeds poses a difficult problem insofar as changes in control force to hold trim with the application of flaps is concerned. This problem was solved on the Martin 202 by the use of an adjustable stabilizer linked with a simple irreversible screw jack and torque tube to the flap. The linkage is nonlinear in action so that trim changes are kept to a minimum for all flap settings. The question has been asked: "What happens if this device fails to function?" The answer is: "The desirable handling characteristics are lost but in no case does the airplane become difficult to handle." Needless to say many flights have been made with the device inoperative. Changes in trim with the application of power were kept to a minimum by choosing the correct angle between the thrust line and the wing chord and by a high location of the horizontal tail.

Control Power

Sufficient elevator control power must be provided to produce first a stall and then the rapid changes in

speed desired during recovery. Enough rudder and aileron must be available to take care of partial engine conditions at low air speeds. The rudder size required for this purpose on high-powered twin-engined airplanes may become so great that, with symmetrical power and full rudder deflection at low speeds, rudder lock or reversal will be encountered. It appears possible that in the future, as more and more power is used on our airplanes and rudders grow larger to handle partial engine flight, we will eventually reach a limit beyond which we cannot go without some nonaerodynamic device to limit rudder throw in the symmetrical power condition.

Stability

Longitudinal control force stability is required by CAR 04b. Friction in the control system is important in this case and must be kept to an absolute minimum or it may mask control feel and make unsatisfactory an otherwise stable airplane. The solution to the large c.g. range on the Martin 202 ($12^1/_2$ to 37 per cent) was obtained by use of a relatively large horizontal tail (33 per cent of the wing area) located high with respect to the wing. Lateral stability at low speeds and appreciable powers is required so that a wing may be raised with the rudder under extreme conditions. This requirement determined the dihedral of the airplane.

Stall Characteristics

Good stall characteristics are required of all airplanes both power-on and power-off. In case of inadvertent stalls sufficient warning and a tendency to nose down rather than roll must be inherent in the design. Stalling qualities are something about which little is known until after a new ship has been flown. We do know that the low drag type of airfoil increases boundary-layer cross flow on the wing. This makes a satisfactory low-speed aileron difficult to achieve and creates a great deal of apprehension as far as stalls are concerned, since they do not seem to follow, in the same way, the patterns we were used to with the old type sections. Furthermore, the power required for power-on stalls, which is determined in level flight with approach flap setting at 1.6 times the stall speed, tends to be high on a high performance airplane because of the large and effective flaps and the high wing loading. Attention must be paid to taper ratio, wing sweep, and wing twist to obtain good stalling qualities under every condition.

Flight Handling Characteristics and Pilot Acceptance

This subject is a controversial one, and I hesitated originally to talk much about it because I am not a pilot. However, I believe it is a problem that must be solved for the engineers because, everything else being equal, the airplane that pilots like to fly will sell better. As mentioned before, this subject cannot be divorced completely from the discussion of flight handling characteristics and safety, but I should like to mention a few characteristics that we believe an airplane should exhibit which do not necessarily affect the safety of flight.

The first of these is the coupling of lateral and directional stability. Theoretically speaking, we think all airplanes should have infinitely large vertical tails. We express this belief in an engineering manner by demanding that full throw of the aileron must not result in more than 2° or 3° of sideslip, rudder free, in addition to the usual directional stability criteria. In an airplane having this flight handling characteristic, which incidentally the 202 has, coordinated maneuvers can be made with the aileron alone.

We are a little bit in the dark as to how a pilot senses the directional stability of an airplane. It may be that his opinion is formed by the amount of yaw developed during an aileron-alone turn, or it may be that he senses directional stability from the yaw angle developed by a given rudder deflection, or perhaps he determines the directional stability by the rapidity with which the airplane returns to zero sideslip when the rudder is released. In any event, if we give him an airplane that is capable of making fully coordinated aileron turns and we use the usual type of aileron, the directional stability as defined by the engineer $dC_n/d\psi$, will be large.

Rudder size will be determined by partial power considerations on a transport airplane, and it may be necessary for us to supply more directional stability than that mentioned above to prevent the pilot from sideslipping to an excessive degree with full rudder deflection. This is especially true if he judges directional stability by the sideslip developed with rudder deflection. Such an approach to the problem shows that we think the aileron is the control surface best suited for making turns, and, if it were not for other conditions requiring a rudder, such as cross-wind take-offs and landings, we would be tempted to leave it off. If the airplane has sufficient dihedral to be laterally stable at low speeds and high powers, in order to meet C.A.A. requirements, it will be possible with the normal rudder size to make fairly good coordinated turns with the rudder alone.

To sum this up, we believe a good flying airplane should be essentially self-coordinating when either the aileron or rudder is used. This approach to the lateral and directional stability coupling was used on the Martin 202, and we think it is one of the qualities that makes the airplane a pleasure to fly.

Part of the lateral and directional coupling problem entails the adverse yawing properties of the airplane. We have found that we must consider the adverse yaw produced during a free-rudder roll in a dynamic sense. Given two airplanes with the same type of ailerons and the same engineering directional stability—one has a very high moment of inertia in yaw and the other very low. When the two airplanes are rolled at the same rate, the one with the low moment of inertia will exhibit much higher adverse yaw than the other. We have

found that this type of an approach to the problem is necessary to obtain good flight handling characteristics from the pilot's standpoint in different types of airplanes. Notice that in the example cited one airplane could be satisfactory, the other unsatisfactory, but if considered from the usual engineering standpoint, both airplanes would be rated the same.

Major Aerodynamic Design Problems

One of the things that causes a great deal of trouble to the aerodynamicist is the difficulty of predicting stall characteristics accurately. This applies not only to the wing but also the vertical and horizontal tail and all the control surfaces. Wind-tunnel models are quite inadequate for determining stall characteristics without extensive flight correlation on the same airfoil and general configuration to tie down scale effects. To date we have found no better way than modifying the airplane during its flight-test period, although it is seldom required. In the early stages of a design, the engineer is usually optimistic and hopeful and tends to predicate design decisions on an optimistic extrapolation of available wind-tunnel data. If, when the airplane finally flies, it encounters poor wing stall characteristics, rudder lock, and elevator reversal, he should not be too surprised. This appears to be the most economical manner in which to approach the problem, because, in a case like this, when we are in doubt about the final outcome, it seems wise initially to leave off all of the fairings, spoilers, etc., that we cannot be certain we absolutely need.

The second major problem we have is the estimation of control forces. Although series after series of tests on wind-tunnel models have been conducted by various agencies to determine hinge moment characteristics, we are as yet unable to predict full-scale hinge moments with the degree of accuracy we desire. When one considers, for example, that the 202 rudder is aerodynamically balanced to a high degree, he will understand why a real problem exists. The area aft of the hinge produces a control force in one direction of a large magnitude; the area forward of the hinge produces a control force of a magnitude almost equal to the first in the opposite direction. The control force the pilot experiences is the difference between these two. Any slight variation that occurs in either one of these components results in an extremely large percentage change in pilot effort and may be the difference between a stable and an unstable control surface. Again, as in the case of stalling qualities, the solution to this problem is usually achieved while the airplane is undergoing flight tests. Allowance is made in the original design for sufficient adjustment in the balance tab ratios and other balancing means to bracket the control force tolerances that are believed to exist. Unfortunately, a balance tab reduces the free control stability of an airplane if the rate of change of hinge moment with angle of attack is negative, which is usually the case. When this condition exists and control forces are too high, we use a spring tab of the preload type to solve the problem. This device is introduced into the control system between the pilot and the control surface. Until the preload is exceeded, the system operates in a perfectly normal manner. Once the preload is exceeded, a tab is actuated by pilot effort to aid in moving the surface. It can easily be seen that such a device makes light control forces obtainable without affecting free control stability. This is one of the nonaerodynamic devices mentioned earlier in the discussion.

Conclusion

The flight handling characteristic problem is indeed an interesting one. It is possible to define flight characteristics that will assure the production of airplanes having safe responses in case of emergency. But in addition to these characteristics, there are others that are influential in producing an airplane that is a pleasure to fly. A few of these have been mentioned, but the list is by no means complete. Should we change our designs to less conventional ones, we shall probably discover many desirable characteristics inherent in the present-day airplane, the existence of which we never before suspected simply because we pay most attention now to the ones that trouble us. These characteristics are difficult to define, and, from the engineering standpoint, the method for their measurement is somewhat in doubt. Only close cooperation and unity of purpose on the part of the engineer and the pilot can solve this difficult problem.

Plan Now to Attend

Wright Brothers Lecture

Washington, D.C., December 17

PROPELLER CONSIDERATIONS for HIGH-SPEED AIRCRAFT

By

HAROLD H. WARDEN

Manager, Installations Department, Propeller Division, Curtiss-Wright Corporation

FIG. 1. Republic P-47D-30 airplane with C5325D-B propeller and 109494 (sweptback) blades.

YEARS AGO, when the design of an aircraft was far simpler than it is today, a propeller was not very complex in design or mechanism. However, through the ensuing years, airplane performance and requirements have increased greatly as improved engines with much higher power outputs have become available. The propeller designer has conducted constant research and development to meet these increasing requirements, and the many new problems they have introduced, such as 1XP vibration resulting from the higher speed and higher wing loading of the modern-day airplane.

As a result of this continued development, the performance of today's propeller is far superior to that of the early designs, and the propeller designer is well prepared to meet the challenge of the modern jet propulsive devices.

Prior to the advent of the high-speed modern aircraft, the available wind-tunnel test data on compressibility effects led many people to believe that propeller efficiencies would fall off drastically at speeds of 400 m.p.h. However, as propeller-driven aircraft exceeded 400 m.p.h., this critical speed was increased to 500 m.p.h. One of the first attempts to get full-scale test data at these high flight speeds was made by the Republic Aviation Corporation during their flight tests on a P-47J airplane, equipped with a conventional propeller. During these tests, this airplane was operated at slightly over 500 m.p.h. at 34,000 ft., with a Curtiss C642S-B propeller with 836-6C2-18 blades of 13-ft. diameter. The tip Mach Number at this operating condition was 1.11, and most of the blade was working considerably above the theoretical "critical Mach Number". A strip analysis for this propeller at this operating condition gave a calculated efficiency of 74 per cent.

Another interesting test was that performed by the Curtiss-Wright Propeller Division on a P-47D-30 airplane equipped with thrust and torque meters and standard production propellers with conventional 836-14C2-18 blades. By diving the airplane, it was possible to obtain very high forward Mach Numbers and to make thrust measurements from which shaft-thrust efficiency could be calculated. During these tests an efficiency of 80 per cent was maintained up to 500 m.p.h., while at the maximum speed of 592 m.p.h. reached in this test, with an airplane Mach Number of 0.84, the efficiency was 62 per cent. These values were particularly significant, since the propeller was designed for approximately 400 m.p.h. and was operating at considerably less than the design lift coefficient of the blades.

After V-E day, our military services uncovered some data in Germany dealing with the development of high-speed propellers, including such unconventional types as the sweptback design. In order to evaluate these data more thoroughly, the Army awarded the Curtiss-Wright Propeller Division a contract to develop, for

flight-test purposes, a series of blades including the sweptback configuration. Accordingly, a test program was initiated for testing such blades on a Republic P-47D-30 airplane, equipped with thrust and torque meters, and incorporating a thrust isolated spinner of a design that provided a minimum of actual fore and aft restraint by the propeller hub, in order to isolate the drag forces acting on the spinner as much as possible. It is believed that the results obtained are the most accurate full-scale flight-test data presently available for propellers operating in the high-speed range of 550 m.p.h.

Three propellers with three different types of blades of 13-ft. diameter were designed for this test and were fabricated from aluminum alloy to reduce tooling time and cost. One blade, designated 109494, had conventional design C_L and thickness but had a sweptback plan form. Fig. 1 shows a front view of this blade as installed on the P-47 airplane with the spinner removed. A side view with the spinner installed is shown on Fig. 2. In many ways, this propeller reminds one of a banana that has been sliced lengthwise.

Fig. 3 shows a view of the straight 109390 test blade with cuffs installed. This blade was designed for optimum performance at 480 m.p.h. at 2,800 b.hp. at 1,260 propeller r.p.m. at 30,000-ft. altitude and had conventional plan form and characteristics.

The third test blade, designated 109498, was the same as the straight 109390 blade but incorporated reduced thickness and design C_L.

A three-bladed, 13-ft. diameter, propeller using 836-14C2-18R1 blades with cuffs was included in the tests as a standard calibration propeller.

Fig. 4 shows the characteristics of these four blades. The 836 blade was, of course, a hollow steel design and had an activity factor of 98.4 and an h/b at the .75R of 0.072.

The "standard" straight 109390 blade and the 1094 sweptback blade had an activity factor of 112 and an h/b at the .75R of 0.060. The "thin" 109498 blade also had an activity factor of 112, but its h/b at the .75R was 0.049.

Fig. 5 shows the variation of design C_L along the blade radius for each of the blades tested. The maximum design C_L for the 836 blade was 0.5, for the "standard" straight 109390 and sweptback 109494 it was 0.51, and for the "thin" 109498 blade it was 0.41. NACA Series 16 airfoil sections were used for all blades tested.

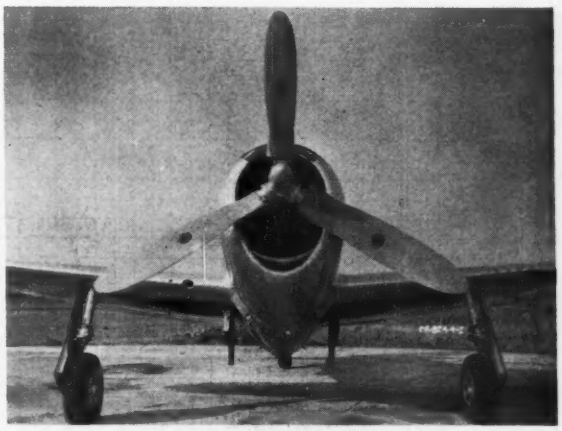

FIG. 3. Republic P-47D-30 airplane with C5325D-B propeller and 109390 blades.

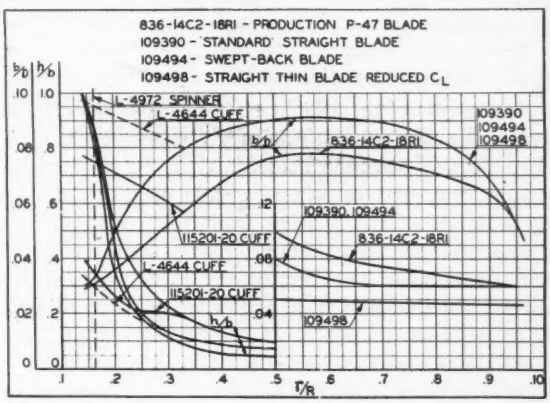

FIG. 4. Blade characteristics.

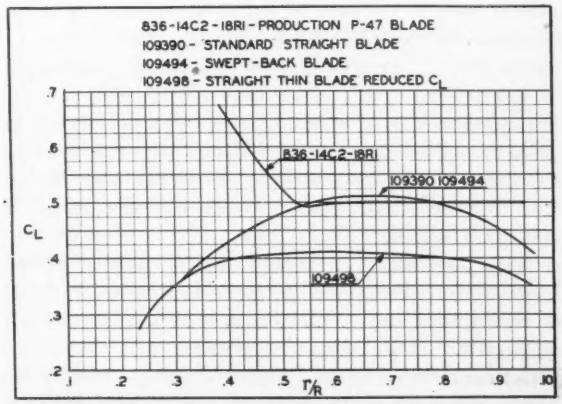

FIG. 5. Blade characteristics.

FIG. 2. Republic P-47D-30 airplane with C5325D-B propeller, 109494 blades, and L-4972 thrust-isolated spinner.

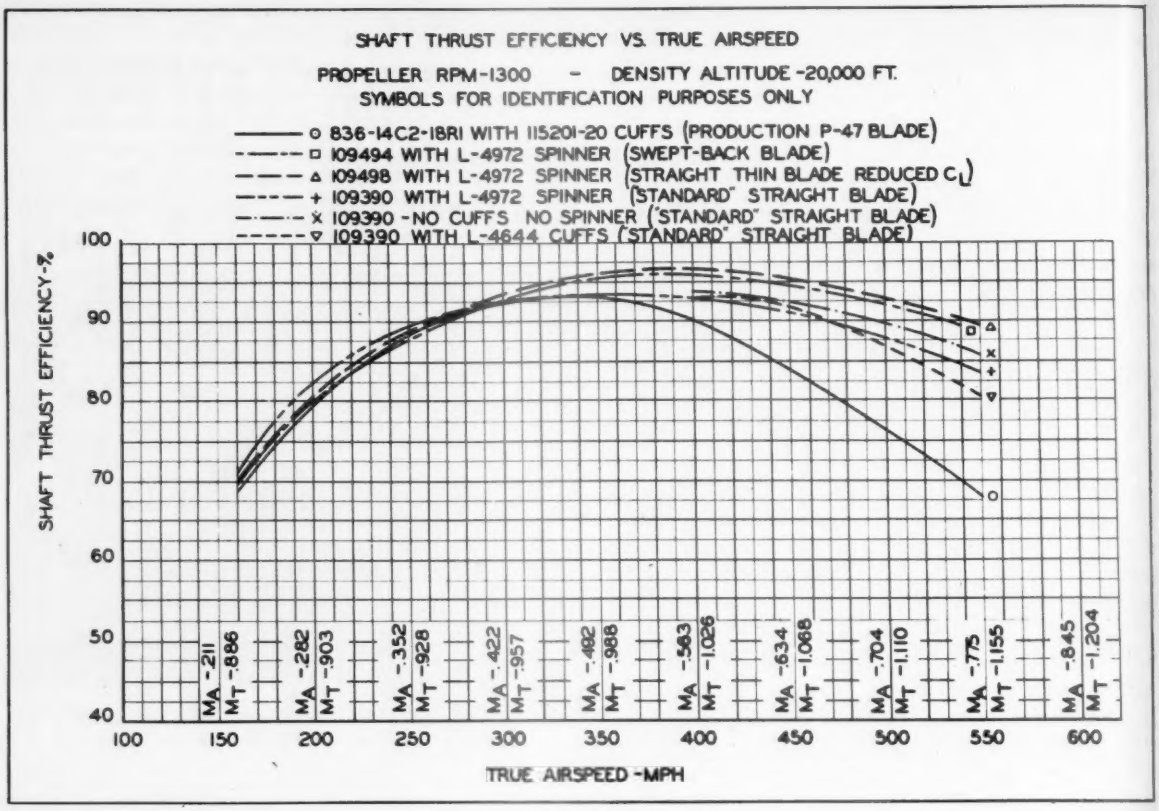
SHAFT THRUST EFFICIENCY VS. TRUE AIRSPEED
PROPELLER RPM-1300 - DENSITY ALTITUDE-20,000 FT.
SYMBOLS FOR IDENTIFICATION PURPOSES ONLY
o 836-14C2-18RI WITH 115201-20 CUFFS (PRODUCTION P-47 BLADE)
□ 109494 WITH L-4972 SPINNER (SWEPT-BACK BLADE)
Δ 109498 WITH L-4972 SPINNER (STRAIGHT THIN BLADE REDUCED C_L)
+ 109390 WITH L-4972 SPINNER ("STANDARD" STRAIGHT BLADE)
x 109390 - NO CUFFS NO SPINNER ("STANDARD" STRAIGHT BLADE)
▽ 109390 WITH L-4644 CUFFS ("STANDARD" STRAIGHT BLADE)
SHAFT THRUST EFFICIENCY-%
100
90
80
70
60
50
40
MA -.211 MT -.886
MA -.282 MT -.903
MA -.352 MT -.928
MA -.422 MT -.957
MA -.492 MT -.988
MA -.563 MT -1.026
MA -.634 MT -1.068
MA -.704 MT -1.110
MA -.775 MT -1.155
MA -.845 MT -1.204
100 150 200 250 300 350 400 450 500 550 600
TRUE AIRSPEED -MPH

FIG. 6. P-47D-30 flight tests.

The results of these flight tests are shown on Fig. 6, which plots shaft-thrust efficiency versus true air speed. No reduction has been made on these curves for slipstream drag and associated effects on the airplane. It is immediately apparent from these curves that, contrary to previous thinking, blades of conventional configuration can be designed for high flight speeds by varying the thickness ratio and design C_L and still give extremely high efficiency. A loss of only about 7 per cent from the peak efficiency at 400 m.p.h. occurs up to flight speeds of 550 m.p.h. with an airplane Mach Number of 0.775 and a tip Mach Number of 1.155.

It will also be seen that improvements of approximately 3 to 5 per cent in propeller efficiency can be obtained by reducing both thickness and design C_L as compared to present practice in the high-speed range of 400 to 550 m.p.h.

Improvements of approximately 2 to 4 per cent in propeller efficiency can be obtained by incorporating sweepback on blades having thickness and design C_L's consistent with present practice in the range of 400 to 550 m.p.h.

It is interesting to note that the 109498 "thin" blade with reduced C_L actually showed slightly higher efficiency than the 109494 blade incorporating sweepback only. It is, of course, possible that additional performance improvement might be obtained by incorporating sweepback, reduced thickness, and reduced design C_L into a single blade design, provided the operating lift coefficient is optimum at the lower design lift coefficient values. However, such a design was not included in this program because of the extremely high steady stresses introduced by the sweepback design.

Another point to be considered in the study of these results is the fact that the 13-ft. diameter propellers were not operating at optimum loading at 550 m.p.h. Reducing the diameter to increase this loading would, it is believed, extend the range of high efficiency to at least 600 m.p.h., and perhaps considerably beyond, before the effects of compressibility, formerly prophesied, would reduce the efficiency below 60 per cent.

Based on these tests, therefore, it has been concluded that high-speed propellers can be designed which will give shaft-thrust efficiencies between 80 to 90 per cent at flight speeds up to 600 m.p.h.

It is true that high 1XP stresses may result from high-speed operation with the straight blades with reduced thickness, provided careful consideration is not given to the installation. However, this reduction in thickness is most effective on the outer portions of the blade, particularly at the tips, whereas the increased section thicknesses required to withstand the 1XP stresses will occur on the inboard portions where the blade operating Mach Numbers are much less. The use of square tips, which are simpler from a fabrication standpoint, will also result in a favorable reduction in section thickness at the tips.

Our increasing knowledge of the factors affecting 1XP aerodynamic excitation has also convinced us that high-speed propellers can be designed to withstand these stresses, although the weight reduction is not expected to be as much as formerly anticipated with operation on such engines as turbines, which have much less inherent vibration characteristics than reciprocating engines.

It appears, from the present trend in engine design, that these high-speed propellers will, in the main, be operated on turbines at propeller r.p.m.'s and tip speeds much less than those used with reciprocating engines. Many present-day reciprocating engine installations operate at rotational tip speeds between 900 and 1,000 ft. per sec. Turbine installation selection, on the other hand, appears to be falling in the range of 800 to 900 ft. per sec.

These low propeller speeds will have a beneficial effect on propeller performance at high flight speeds by reducing the operating Mach Number at the tips, thus tending to further extend the range of good efficiency.

Summarizing, we can predict that high-speed propellers for the immediate future will have the same general straight plan form and NACA Series 16 airfoil sections, as at present, and square tips. The design C_L will be approximately 0.4, and the section thickness will be reduced, particularly at the tips, as much as possible, compatible with 1XP stresses. Efficiencies comparable to those presently obtained at relatively low-speed operation are expected to be retained to at least 600 m.p.h.

In our studies we have considered turbine propeller blades having activity factors in basic diameter of both 125 and 150, with the possibility of designing the higher activity factor blade with an extended trail edge. This results in a possible activity factor range of 125 in basic to 175 in cutoff diameter. Generally speaking, our studies indicate that the optimum propeller for a 5,000-hp. turbine or less will be single rotation and have a diameter of 13 to 17 ft. For turbines of greater horsepower, single rotation propellers ranging in diameters of 17 to 25-ft. appear to be required. When diameter limitation is necessary, six- and eight-bladed, dual rotation propellers offer an excellent solution.

Associated with this problem of increased propeller efficiency at high speeds is that of shank losses, which may be reduced by providing a configuration in which only the thrust producing part of the blade is exposed. Practical application of such a configuration could conceivably be a small-diameter, single-rotation propeller using approximately eight or ten blades. A wind-tunnel model of such a propeller is under development for the Navy at present for operation and testing by the N.A.C.A.

Another high-speed flight problem indirectly related to propeller design is that of high-speed cowls required to improve ram and reduced rag. The Propeller Division has conducted an extensive analytical study of such high-speed cowls, including the annular or N.A.C.A. type "E" and the N.A.C.A. type "D" with an extended nose, with particular reference to their application on propeller-gas-turbine installations. The results of this investigation indicate that a type "E" cowl could be designed to give between 90 to 95 per cent overall ram recovery, but that this aerodynamic advantage may well be nullified by the following disadvantages:

(1) The greater weight of the total installation.

(2) The possibility of adverse effects resulting from ice formation.

(3) The complexity of design which will require increased maintenance and service.

(4) The decreased accessibility of the hub and blade shanks for inspection and service.

In view of these disadvantages, it has been concluded that if a type "D" cowl can be designed to give less than 10 per cent ram loss, it probably should be used in preference to the type "E" cowl.

Although not strictly within the scope of a paper dealing with high-speed propeller performance, the advent of the aircraft gas turbine has introduced many new problems that have necessitated an entirely new approach to the propeller control problem. The gas turbine is, essentially, a constant-speed power plant and gives lowest specific fuel consumption at maximum power. Therefore, its performance is fundamentally limited by the maximum permissible r.p.m. of the rotating elements and the maximum permissible temperature for the elements exposed to the combustion gases. Consequently, a much more precise control system is required for the propeller and turbine than that now used on reciprocating engines.

There are two schools of thought regarding turboprop control systems. One is based on control of temperature (or power) by fuel flow adjustment and control of r.p.m. by blade angle adjustment, similar to the control system of a conventional reciprocating engine. The other is opposite in its approach and is based on control of temperature (or power) by blade angle adjustment and control of r.p.m. by fuel flow adjustment. The Propeller Division currently has a specialized group of engineers engaged in the investigation of both of these methods of control.

At this point, one may naturally raise the question as to the relative performance of the turbojet and turboprop power plants. Assuming that good propeller efficiency will still be obtained at speeds as high as 600 m.p.h., will the thrust horsepower output of the propeller engine itself compare favorably with the net thrust output of the jets, particularly at high altitudes?

This problem has been explored extensively throughout the industry, and there are a number of technical papers available discussing these various studies, all of which more or less agree that the turbopropeller power plant will be optimum up to speeds of 600 m.p.h. There is insufficient space to review these studies in

(*Continued on page 87*)

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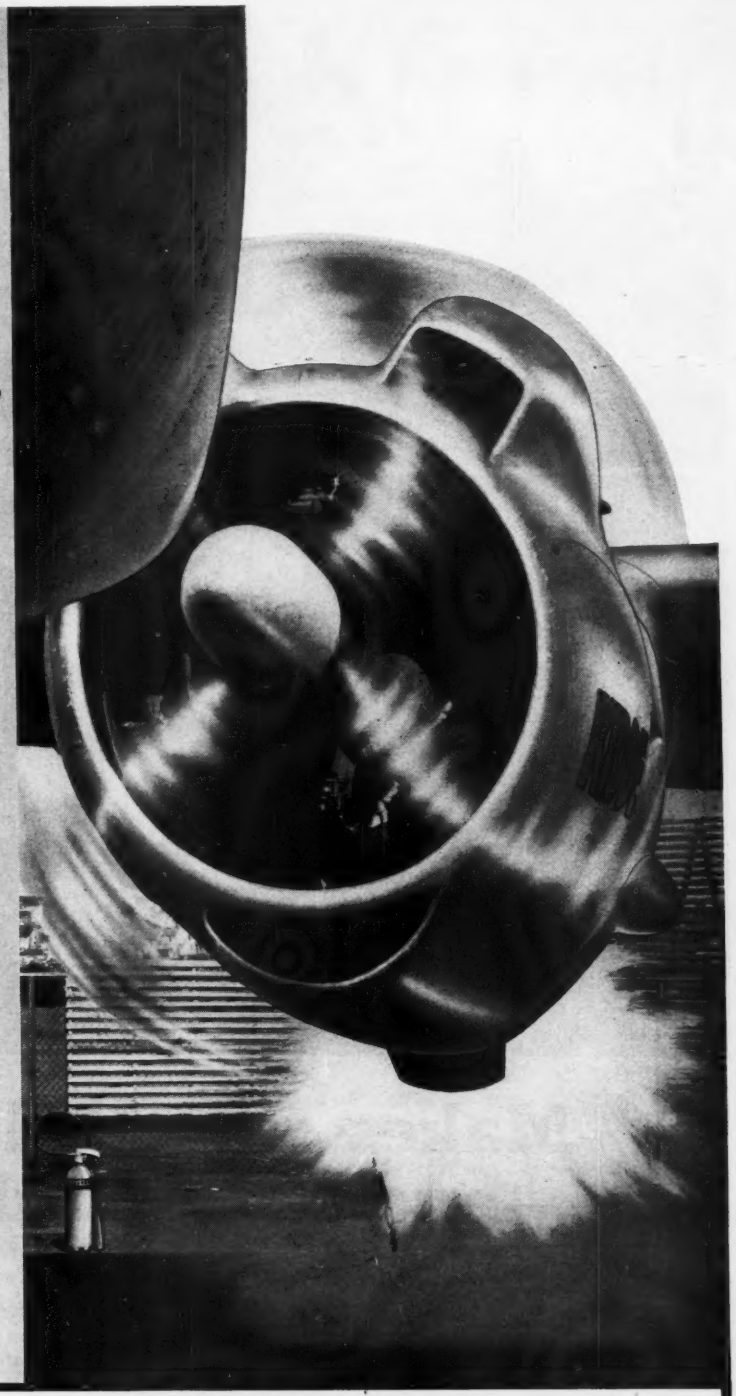

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The abstracts are classified according to the Standard Aeronautical Indexing System. Numbers in parentheses indicate the position of the Division Headings in the numerical arrangement. Headings marked by an asterisk have not yet been established by the S.A.I.S.

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A Simplified Introduction to High Speed Flight. T. F. Weldon 81
Reviewed by Dr. J. F. Ludloff, New York University

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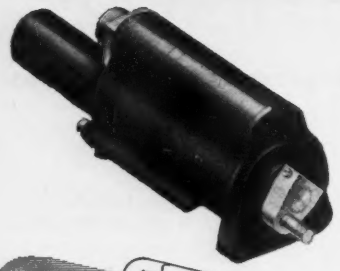

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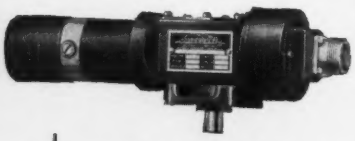

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Aerodynamics (2)

AERODYNAMIC LOADS

Rationalization of Symmetrical Gust Load Requirements. F. J. Plantema. **Appendix.** J. H. Greidanus. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S.315,* November 6, 1946. 10 pp., figs. (In English.)

An analysis of gust data confirms the prescriptions of the Airworthiness Division of PICAO for gust gradient distance and gust alleviating factor. A plotted family of curves shows the gust alleviating factor as a function of the wing chord.

BOUNDARY LAYER

Boundary Layer in Compressible Fluid. J. A. Lewis and G. F. Carrier. (*Monograph No. 5.*) *U.S., Air Force, Technical Report No. F-TR-1179-ND,* February, 1948. 66 pp., figs. 18 references.

A discussion based on current domestic and foreign literature on the boundary-layer phenomena in compressible-fluid flow. The calculation of velocity and temperature distributions in the flow, frictional drag exerted by the flowing gas on the surface of the boundary, and the heat transfer across the solid boundary omit the question of stability of the flow, the effect of turbulence, and the interaction of the viscous boundary layer with the compression shocks that may occur in transonic and supersonic flows. The boundary-layer equations, relating the convection of enthalpy with the heat caused by compression and friction and the heat conducted through the fluid, are derived from the fundamental equations of continuity, motion, energy, and state. Their solution when the Prandtl Number is unity is outlined according to the method of Busemann and the method of von Kármán and Tsien. For the case in which the Prandtl Number is not unity, L. Crocco's method is used. Solutions for arbitrary Prandtl Number and viscosity relations may be obtained according to the method of Emmons and Brainerd and by a numerical method devised by L. Crocco. The results that were obtained by the restrictive assumptions that lines of constant velocity are isothermals, that the Prandtl Number is unity, or that the product of the density and viscosity is constant are compared with more exact results obtained by Crocco and by Emmons and Brainerd. An analysis of flow along a plate shows that the cooling efficiency of a flow past a flat plate decreases markedly with increasing Mach Number.

Integration of the Laminar Boundary Layer Over a Flat Plate With and Without Heat Transmission. W. Hantzsche and H. Wendt. (*Lilienthal-Gesellschaft für Luftfahrtforschung, ZWB/LG/139-2.*) *U.S., Air Force, Translation No. F-TS-2072-RE,* April, 1948. 12 pp., figs. 3 references.

Integration of the differential equation of boundary layer on a flat plate for chosen Prandtl Numbers. Liquid and compressible flow are considered separately. Velocity curves show that, up to the speed of sound, the effect of compressibility may be ignored for uncooled or unheated plates. Curves for the latter show results for cases of heat transmission. Mach Numbers up to 8.8 and the theoretical case of Mach Number equals infinity are considered.

Determination of General Relations for the Behavior of Turbulent Boundary Layers. Albert E. von Doenhoff and Neal Tetervin. *U.S., N.A.C.A., Report No. 772,* 1943. 25 pp., figs. 14 references, U.S. Govt. Printing Office, Washington. $0.20.

Some Fundamental Similarities Between Boundary-Layer Flow at Transonic and Low Speeds. Gerald E. Nitzberg and Stewart Crandall. *U.S., N.A.C.A., Technical Note No. 1623,* June, 1948. 30 pp., figs. 9 references.

An analysis of the behavior of a boundary layer in subsonic flow under laminar-, separated-, and turbulent-flow conditions is shown to be applicable to behavior of the boundary layer in transonic flow. The similarity between the two types of flow permits the development of methods of estimating the growth of the boundary layer in the regions of laminar separation and transition, the calculation of growth of turbulent boundary layer, the chordwise location of its separation point, and an approximation of boundary-layer growth through a shock wave.

Analysis of the Effects of Boundary-Layer Control on the Take-Off Performance Characteristics of a Liaison-Type Airplane. Elmer A. Horton and John H. Quinn, Jr. *U.S., N.A.C.A., Technical Note No. 1597,* June, 1948. 61 pp., figs. 14 references.

Boundary-layer control by suction does not reduce the absolute minimum total take-off distance of a liaison-type airplane with a

low wing loading and moderately low aspect ratio. Its effectiveness in reducing the total take-off distance for a given maximum speed improves with increasing aspect ratio, and, for wing loadings of 10 lbs. per sq.ft. or more and an aspect ratio of 10 or more, it decreases the total take-off distance. This reduction was negligible for aspect ratio of 5 but was from 10 to 30 per cent for aspect ratios of 10 and 15. For a given maximum speed a reduction in stalling speed of 20 to 25 per cent was obtained. The optimum horsepower loading for minimum take-off distance was approximately 815 for the conventional and 9.0 lbs. per hp. for the boundary-layer-control airplane.

CONTROL SURFACES

Case Against the Vertical Fin. *Aviation Week*, Vol. 48, No. 21, May 24, 1948, pp. 23, 24, illus.

Summary of N.A.C.A. investigation of all-movable horizontal tail surfaces and an all-movable vertical stabilizer. Results indicate possible reduction in drag, greater safety, and increased controllability.

Dorsal Fin: Aids Stability, But How? Robert McLarren. *Aviation Week*, Vol. 48, No. 23, June 7, 1948, p. 26. 5 references.

Tail Loads in Pull-Ups. I, II. F. J. Plantema. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S.289, S.292*, July, 1946. 2 pp. (In English.)

A summary of two reports that revise and amplify the basic considerations underlying Reports Nos. V.1354 and V.1376 on tail loads and strength requirements during pull-ups.

De Belasting op het Horizontale Staartvlak bij het Optrekken van Vliegtuigen uit de Horizontale Vlucht (Tail Load During a Pull-Up of an Aircraft From Horizontal Flight). III. L. R. Lucassen. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1354*, July 12, 1945. 28 pp., figs. 4 references. (In Dutch.)

The tail load on an aircraft during a pull-up from horizontal flight was calculated from the equations of motion perpendicular to the flight path and of motion about the lateral axis. The change of elevator deflection from its position during horizontal flight was represented as the product of the maximum deflection and a factor that contained the deflection time as a parameter. Substitution of the expression for elevator deflection in the ordinary equations of motion made it possible to obtain an ordinary differential equation of the second order in the angle of incidence which could be solved for the maximum tail loads at various rates of elevator deflection. Computations for the Douglas DC-2 showed that the maximum tail loading increases with rate of deflection. When the maximum deflection was reached in 0.5 sec., the maximum tail load was 45 per cent less than when its duration was only 0.2 sec.

Investigation of an Approximately 0.178-Chord-Thick NACA 6-Series-Type Airfoil Section Equipped With Sealed Internally Balanced 0.20-Chord Ailerons and With a 0.05-Chord Tab. Fioravante Visconti. *U.S., N.A.C.A., Technical Note No. 1590*, May, 1948. 28 pp., figs. 6 references.

The results of the tests indicated that increasing the aileron profile thickness from that of a true-contour to that of a straight-sided aileron would increase positively the rate of change of aileron section hinge-moment coefficient with both section angle of attack and aileron deflection and would cause little change in the hinge-moment parameter for a given rate of roll at low aileron deflections. The effectiveness of the tab in reducing the aileron section hinge moments is large at low angles of attack and low aileron deflection but decreases appreciably at high aileron deflections.

Derivation of Charts for Determining the Horizontal Tail Load Variation With Any Elevator Motion. Henry A. Pearson. *U.S., N.A.C.A., Report No. 759*, 1943. 15 pp., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.15.

FLUID MECHANICS & AERODYNAMIC THEORY

Experiments in Transonic Flow. Jean G. Goppert and Joseph Flatt; Hans W. Liepmann, Harry Askenas, and Julian D. Cole. *U.S., Air Force, Technical Report No. 5667*, February 9, 1948. 126 pp., illus., figs. 34 references.

A theoretical analysis of transonic flow in which the general equations and the similarity law are developed. Current opinions are summarized on the problems presented by potential flow under transonic conditions, the effects of viscosity and the mechanics of the boundary layer and shock waves, the interaction effects between a laminar boundary layer and a supersonic outer flow field, and the influence of the shock wave on the boundary layer upstream. Schlieren photographs and pressure measurements on the surface of the profile and in the neighborhood of the profile were made in the 20- by 20-in. transonic wind tunnel with circular arc airfoil sections at zero angle of attack. When the critical Mach Number was barely exceeded, a symmetrical supersonic zone was formed in which the compression to subsonic occurred smoothly. Only nonstationary weak shock waves were formed. The shapes of the stationary shock waves that developed at higher Mach Numbers were characteristic either for laminar or turbulent boundary layer. The change from laminar to turbulent flow is independent of starting conditions, and no appreciable hysteresis was found. The behavior of the laminar layer in a supersonic flow differs from that in subsonic flow in that it is strongly influenced by downstream conditions, thickening and sometimes separating in a region in which normal potential theory predicts a decrease in pressure. Supersonic flow bounded by a laminar layer behaves in many instances like a free jet. A laminar boundary layer influenced the pattern of a shock wave reflected from a solid boundary up to distances of at least the order of 100 times the boundary-layer thickness. The influence of a turbulent layer was much smaller. The different types of shock wave for laminar and turbulent boundary layers in transonic flow do not correspond to different potential solutions, as previously proposed, but can be attributed to the change in the boundary conditions alone.

Berechnung der Druckverteilung um Rotationkörper bei Unter- und Ueberschallgeschwindigkeiten mit Hilfe des Quell-Senken-Verfahrens (Calculation of the Pressure Distribution Around Bodies of Revolution at Sub- and Supersonic Speeds by Means of the Method of Sources and Sinks). S. F. Erdmann. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F.3*, December 20, 1946. 35 pp., figs. (In German.)

A method of sources and sinks for calculating the pressure distribution on slender bodies of rotation. This extension of the work of R. Sauer, which was based on Fuhrmann, von Kármán, and Ferrari, leads to a distribution of sources with constantly changing intensity and yields a quasirigorous solution for the incompressible case that serves as an approximation for compressible flow. The subsonic calculations are based on work of von Kármán and Moore as further extended in a heretofore unpublished investigation by Haack and are carried out to a final approximation. A comparison of the results from this method with those from the rigorous method of characteristics show a good agreement between measurements and computations in subsonic flow. The supersonic calculations made for Mach 1.87 and Mach 2.47 gave equivalent results for the rigorous method of characteristics and for two different formulations of the source-sink method. In the nose region, theory and experiment were in good agreement for both the method of characteristics and the source-sink method, but in the cylindrical section and in the vicinity of the tail, results were unsatisfactory because of the boundary layer, which is not accounted for in the calculations. The stream function in incompressible flow and the pressure distribution according to the second formulation at Mach 2.1 are calculated. A tabulation of the stream function for a parabolic source distribution in subsonic flow shows an exceptionally good agreement with the assumed body shape.

Investigation of the Penetration of an Air Jet Directed Perpendicularly to an Air Stream. Edmund E. Callaghan and Robert S. Ruggeri. *U.S., N.A.C.A., Technical Note No. 1615*, June, 1948. 13 pp., figs.

Experiments were conducted to determine the penetration of a circular air jet directed perpendicularly to an air stream as a function of jet density, jet velocity, air-stream density, air-stream velocity, jet diameter, and the distance downstream of the jet. The penetration was determined for nearly constant values of air-stream density at two tunnel velocities, for four jet diameters, for four positions downstream of the jet, and for a large range of jet velocities and densities. An equation for the penetration was obtained in terms of the jet diameter, the distance downstream of the jet, and the ratios of jet and air-stream velocities and densities.

Calculations of Air Flow in the Vicinity of Fuselages. F. K. Schmidt. (*Deutsche Forschungsanstalt für Segelflug, Ainring*, July, 1945.) *U.S., Air Force, Translation No. F-TS-2615 (ATI-19130)*, May, 1948. 24 pp.

Calculation of the velocity distribution in laminar flow around an aircraft fuselage which does not necessarily have rotational

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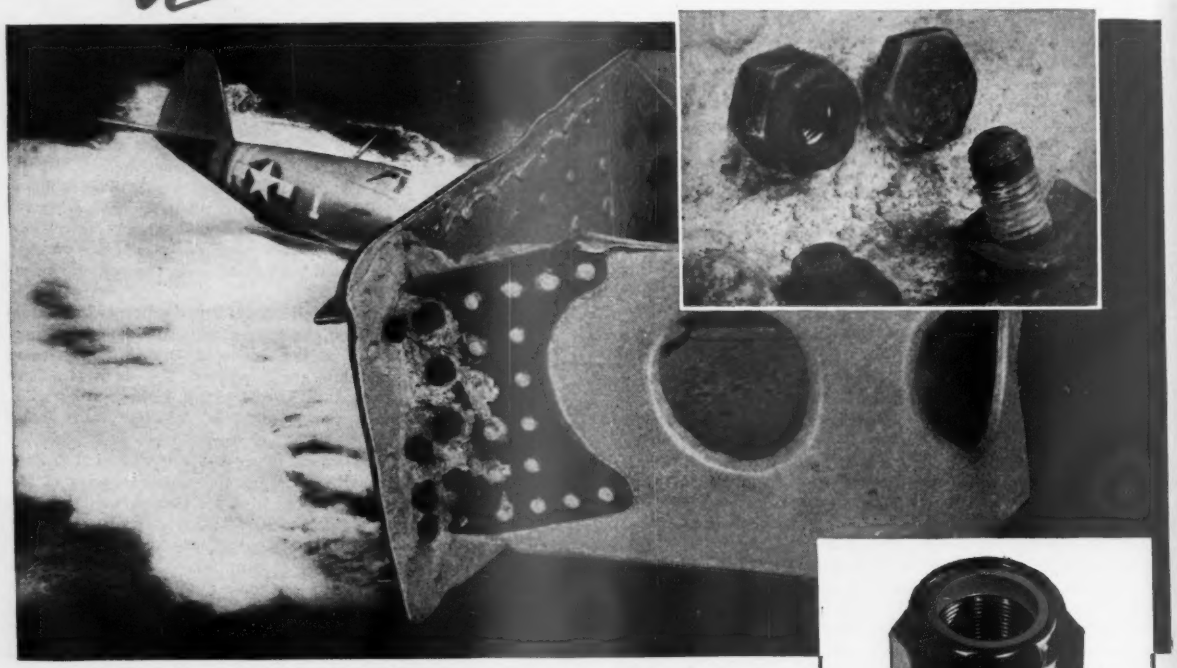

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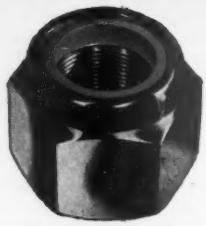

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Hypersonic Flow Over a Slender Cone. S. F. Shen. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 56–66, figs. 8 references.

An application of the equations and similarity laws for two-dimensional and axially symmetrical flows to the hypersonic flow condition that exists when the free stream Mach Number is extremely large and the thickness of the body immersed in the stream is small such that the product of the Mach Number and the thickness ratio is of the order one. A set of equations are obtained for surrounding a continually expanding cylinder which differs from Taylor's solution for wave surrounding a continually expanding sphere only in the constant factor in the term involving no derivatives in the equation of continuity. Their numerical solution is obtained by expanding the solution into a series near the initial point and using a standard numerical integration thereafter. These results are compared with numerical solutions of both Taylor and Kopal for the exact equation for supersonic flow over cones of various angles, the linearized supersonic flow solution, and that for hypersonic flow over wedges.

On Supersonic Flow Past a Slightly Yawing Cone. A. H. Stone. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 67–81, figs. 5 references.

An investigation of the flow in the region between the shock wave at the nose of a projectile and the expansion wave that arises at its shoulder when the axis of symmetry makes a small angle with the direction of flow of the free stream. Experimental observations confirm the predicted aerodynamic forces on the head of the projectile and the configuration of the shock wave. These theoretical results can serve as a check of various approximate methods that have wider applicability.

Tables for Numerical Solution of Problems in Compressible Gas Flow with Energy Effects. Ascher H. Shapiro and Gilbert M. Edelman. *Journal of Applied Mechanics*, Vol. 15, No. 2, June, 1948, pp. 169–175. 2 references.

Tables of functions for solving problems in one-dimensional, compressible gas flow when energy effects, as represented by changes in stagnation temperature, are involved. The tables may be used for typical processes as heat transfer at high gas speeds, combustion, moisture condensation shocks, flame fronts, and detonation waves. The Mach Number is the independent argument of the tables. There is one table for each of six specific-heat ratios, 1.0, 1.1, 1.2, 1.3, 1.4, and 1.67.

The Mechanics and Thermodynamics of Steady One-Dimensional Gas Flow. A. H. Shapiro and W. R. Hawthorne. **Discussion.** G. M. Dusinberre. N. A. Hall. Philip Rudnick. *Journal of Applied Mechanics*, Vol. 15, No. 2, June, 1948, pp. 179–181. 1 reference. (Cf. AER 4/48:44.)

Stability of Boundary Layers and of Flow in Entrance Section of a Channel. Elizabeth Hahneman, J. C. Freeman, and M. Finston. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 493–496, figs. 11 references.

Lin's approximate formula for the minimum critical Reynolds Number is used to study the entrance flow into a channel, the boundary layer with pressure gradient, and the boundary layer with suction. The results obtained compare favorably with much more elaborate calculations wherever they are available. In the case of the entrance flow into a channel, the new result is found—that the entrance section is comparatively more stable than the fully developed parabolic velocity distribution.

On the Flow of a Compressible Fluid by the Hodograph Method. II—Fundamental Set of Particular Flow Solutions of the Chaplygin Differential Equation. I. E. Garrick and Carl Kaplan. *U.S., N.A.C.A., Report No. 790*, 1944. 21 pp., figs.

The Flow of a Compressible Fluid Past a Curved Surface. Carl Kaplan. *U.S., N.A.C.A., Report No. 768*, 1943. 23 pp., figs. U.S. Govt. Printing Office, Washington. $0.20.

On a New Method for Calculating the Potential Flow Past a Body of Revolution. Carl Kaplan. *U.S., N.A.C.A., Report No. 752*, 1943. 13 pp., figs. 3 references. U.S. Govt. Printing Office, Washington. $0.15.

On the Flow of a Compressible Fluid by the Hodograph Method. I—Unification and Extension of Present-Day Results. I. E. Garrick and Carl Kaplan. *U.S., N.A.C.A., Report No. 789*, 1944. 24 pp., figs. 9 references. U.S. Govt. Printing Office, Washington. $0.20.

INTERNAL FLOW

The Flow of a Perfect Fluid Through an Axial Turbomachine With Prescribed Blade Loading. Frank E. Marble. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 473–485, figs. 10 references.

A quantitative description of the three-dimensional velocity field that prescribes the mean blade flow of an axial-flow turbomachine and indicates the accuracy with which two-dimensional airfoil theory may be applied to each element of the blade. The simplifying assumptions that are introduced reduce the nonlinear equations that describe the rotational fluid motion to the solution of a well-known nonhomogeneous linear partial differential equation and give linear approximation to the radial, tangential, and axial velocities associated with any loading of a blade of finite chord or an infinitely thin blade row corresponding to a discontinuous change of tangential velocity. When the discontinuity is located appropriately, it constitutes a useful approximation to the solution for a finite blade chord. An exponential approximation for the velocity components, using the superposition principle, provides both a simple means of approximating the velocity distribution in a multistage turbomachine and of discussing mutual interference of blade rows.

Effect of Size and Number of Outlet Pipes on Design of Collectors for Rating and Testing Axial-Flow Compressors. Jason J. Moses and Thomas I. Kazberovich. *U.S., N.A.C.A., Technical Note No. 1607*, June, 1948. 19 pp., figs. 2 references.

Airflow studies were made of an experimental collector on which six different outlet configurations were used to determine effects of size and number of outlet pipes on static-pressure distribution at collector inlet, flow limitation, and total-pressure losses downstream of collector inlet. Results indicated that size and number of outlet pipes apparently had little effect on static-pressure distribution at collector inlet but that, for a collector with sudden expansion at the inlet, the ratio of cross-sectional outlet-pipe area to cross-sectional collector-inlet area had to be greater than 2.0 to prevent choking in the outlet pipes.

On the Plane Potential Flow Past a Lattice of Arbitrary Airfoils. I. E. Garrick. *U.S., N.A.C.A., Report No. 788*, 1944. 16 pp., figs. 12 references. U.S. Govt. Printing Office, Washington. $0.15.

PARASITIC COMPONENTS & INTERFERENCE

Experiments on Drag of Revolving Disks, Cylinders, and Streamline Rods at High Speeds. Theodore Theodorsen and Arthur Regier. *U.S., N.A.C.A., Report No. 793*, 1944. 18 pp., figs. 10 references. U.S. Govt. Printing Office, Washington. $0.15.

STABILITY & CONTROL

The Effect of Variations in Moments of Inertia on Spin and Recovery Characteristics of a Single-Engine Low-Wing Monoplane With Various Tail Arrangements, Including a Twin Tail. Anshal I. Neihouse. *U.S., N.A.C.A., Technical Note No. 1575*, May, 1948. 45 pp., illus., figs. 9 references.

Results of an investigation made in the Langley 15-ft. free-spinning tunnel of the effects of variation of the moment of inertia of a research model representative of a present-day trainer or a four-place cabin monoplane. Eight different wing arrangements and four different tail arrangements, including a twin tail, were tested. The moments of inertia about the three airplane axes were increased or decreased by a constant percentage and the results were compared. These results were also compared with previous results for variation of the airplane relative density.

Effect of Landing Flaps and Landing Gear on the Spin and Recovery Characteristics of Airplanes. Lawrence J. Gale. *U.S., N.A.C.A., Technical Note No. 1643*, June, 1948. 14 pp., figs. 6 references.

The effect of landing flaps and landing gear on the spin and recovery characteristics of airplanes has been determined from an analysis of the results of spinning investigations of 58 models in the Langley 15- and 20-ft. free-spinning tunnels. The results indicate that generally an adverse effect on recovery characteristics was obtained when the flaps were in an extended position during

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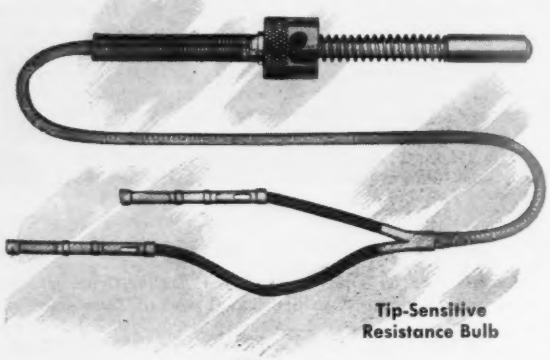

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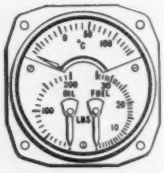

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the spin. Extension of the landing gear usually had a negligible effect on the spin-recovery characteristics.

Effects of Small Angles of Sweep and Moderate Amounts of Dihedral on Stalling and Lateral Characteristics of a Wing-Fuselage Combination Equipped With Partial- and Full-Span Double Slotted Flaps. Jerome Teplitz. *U.S., N.A.C.A., Report No. 800,* 1944. 20 pp., figs. 2 references. U.S. Govt. Printing Office, Washington. $0.20.

An Interim Report on the Stability and Control of Tailless Airplanes. Langley Stability Research Division. Compiled by Charles J. Donlan. *U.S., N.A.C.A., Report No. 796,* 1944. 16 pp., figs. 21 references. U.S. Govt. Printing Office, Washington. $0.15.

A Theoretical Investigation of Longitudinal Stability of Airplanes With Free Controls Including Effect of Friction in Control System. Harry Greenberg and Leonard Sternfield. *U.S., N.A.C.A., Report No. 791,* 1944. 21 pp., figs. 11 references. U.S. Govt. Printing Office, Washington. $0.20.

A Method for Studying the Hunting Oscillations of an Airplane With a Simple Type of Automatic Control. Robert T. Jones. *U.S., N.A.C.A., Report No. 801,* 1944. 4 pp., figs. 3 references.

Flight Measurements of the Flying Qualities of Five Light Airplanes. Paul A. Hunter. *U.S., N.A.C.A., Technical Note No. 1573,* May, 1948. 83 pp., illus., figs. 3 references.

WINGS & AIRFOILS

Characteristics of Thin Triangular Wings With Triangular-Tip Control Surfaces at Supersonic Speeds With Mach Lines Behind the Leading Edge. Warren A. Tucker. *U.S., N.A.C.A., Technical Note No. 1600,* May, 1948. 33 pp., figs. 9 references.

A theoretical analysis, based on the linearized equation for supersonic flow, of characteristics of triangular-tip control surfaces on thin triangular wings. By restriction to the case for which Mach lines from the wing apex lie behind leading edge, a simplified treatment was possible; results of previous work on lift of triangular wings could be used to derive expression for lift effectiveness, pitching moment, rolling moment effectiveness, hinge moment due to control deflection, and hinge moment due to angle of attack. Comparisons were made with the two-dimensional case.

Theoretical Distribution of Lift on Thin Wings at Supersonic Speeds (An Extension). John C. Evvard. *U.S., N.A.C.A., Technical Note No. 1585,* May, 1948. 49 pp., figs. 8 references.

A derivation based on linearized theory shows that the theoretical pressure distribution on thin wings at supersonic speeds may be obtained from a line integral and a surface integral. For thin flat-plate wings or for the lift distribution on finite-thickness wings, only line integrals are required. By way of illustration, the lift distribution is evaluated for a wing having a straight leading edge intersected by an arbitrarily shaped curve whose boundary line elements are swept behind the Mach line from the wing-tip and leading-edge intersection. Expressions are formulated for the velocity potential in regions influenced by subsonic trailing edges. The solution satisfying the Kutta-Joukowski condition for a swept trapezoidal wing is given and sidewash and upwash velocities in the vicinity of the wing tip are calculated. By a further application of this method, employing series expansions, the mathematical form of the lift distribution associated with the wake behind a general subsonic trailing edge may be indicated. When this result is combined with the line integrals used in connection with thin flat-plate wings, expressions are obtained for the lift distribution of arbitrary-plan-boundary single wing tips at supersonic speeds.

Stability Derivatives of Triangular Wings at Supersonic Speeds. Herbert S. Ribner and Frank S. Malvestuto, Jr. *U.S., N.A.C.A., Technical Note No. 1572,* May, 1948. 20 pp., figs. 8 references.

The analysis of the stability derivatives of low-aspect-ratio triangular wings at subsonic and supersonic speeds is extended to apply to triangular wings having large vertex angles and traveling at supersonic speeds. The surface potentials for angle of attack and rolling are used to obtain the lift due to downward acceleration, the several side-force and yawing moment derivatives that depend on leading-edge suction, and a tentative value for the rolling moment due to yawing. All the known stability derivatives of the triangular wing at supersonic speeds, regardless of source, are summarized and presented with respect to both body axes and stability axes. The results are limited to Mach Numbers for which the triangular wing is contained within the Mach cone from its vertex.

The Calculation of Downwash Behind Supersonic Wings With an Application to Triangular Plan Forms. Max A. Heaslet and Harvard Lomax. *U.S., N.A.C.A., Technical Note No. 1620,* June, 1948. 43 pp., figs. 8 references.

A method is developed, consistent with the assumptions of small perturbation theory, which provides a means of determining for a known load distribution the downwash behind a wing in supersonic flow. The analysis is based upon the use of supersonic doublets distributed over the plan form and wake of the wing in a manner determined from the wing loading. The first application of the method proves the equivalence in subsonic and supersonic flow of the downwash at infinity corresponding to a given load distribution. The principal application is made with the downwash behind a triangular wing with leading edges swept back of the Mach cone from the vertex. A complete solution is given along the centerline of the wake, and an approximation is provided for points in the vicinity of this line.

Note on the Lift of a Triangular Wing at Supersonic Speeds. Richard Calvin Roberts. *Journal of Mathematics and Physics,* Vol. 27, No. 1, April, 1948, pp. 49–55, figs. 1 reference.

The lift at supersonic speeds of the generalized delta wing with any triangular plan form whose base is perpendicular to the free stream flow. The problem for small angles of attack is reduced to a boundary value problem in two dimensions by transforming the linearized equation for the velocity components into polar coordinates and expressing it as an analytic function of a complex variable. A series of conformal transformations is used to obtain a generalized solution for the case where the trailing apexes of the triangle are not equidistant from the origin of the Mach cone.

A Wing-Body Problem in a Supersonic Conical Flow. S. H. Browne, L. Friedman, and I. Hodes. *Journal of the Aeronautical Sciences,* Vol. 15, No. 8, August, 1948, pp. 443–52, figs. 8 references.

The linearized potential equation for steady-state supersonic flow is solved for a slender conical body with a thin symmetrical wedge wing extending to infinity in the direction of flow. The potential function is divided into symmetric and antisymmetric parts, the first of which corresponds to a flow arising from thickness distribution with no lift, while the second arises from a superposed cross-flow that determines the angle of attack and gives rise to lift. Pressure distributions are computed for both cases. In the symmetric case the resultant pressure is less than that of either wing and body contributions but never less than that of either element alone. In the antisymmetric case, if the wing is wide, the pressure and lift curve slope are nearly those of a wing of the same plan form and angle of attack. As the wing is made narrower, the effective angle of attack of the system increases.

Chordwise and Spanwise Loadings Measured at Low Speed on a Triangular Wing Having an Aspect Ratio of Two and an NACA 0012 Airfoil Section. Bradford H. Wick. *U.S., N.A.C.A., Technical Note No. 1650,* June, 1948. 28 pp., figs. 6 references.

Pressure measurements showed the loading on the wing to be similar to that of highly tapered wings of conventional plan form. The section nearest the tip was first to stall and was more highly loaded than the other sections. The effects of three-dimensional flow made it impossible to predict either the chordwise pressure distributions or the maximum loadings of the wing sections from two-dimensional data. The span load distribution for the wing, however, could be accurately calculated by Weissinger's lifting-line method for angles of attack below tip stall.

Note on the Limits to the Local Mach Number on an Aerofoil in Subsonic Flow. A. D. Young. *College of Aeronautics, Cranfield, England, Report No. 14,* April, 1948. 9 pp., figs. 2 references.

Summaries of two proposed explanations for the limiting value that in some experiments has appeared to be characteristic of the local Mach Number just ahead of a shock wave on an airfoil in subsonic flow. The first explanation starts with the observation that the pressure after the shock will not be higher than the main stream pressure. Calculations of the relation between the local Mach Number ahead of the shock, the shock inclination, the main-stream Mach Number, and the pressure coefficient just aft of the shock show that for given main-stream Mach Number, pressure coefficient, and inclination, two shocks are possible, one strong, for which the local Mach Number ahead of the shock will exceed 1.48, and the other weak, with an associated local Mach Number less than 1.48. In practice this weaker shock is the more likely

to occur. The second approach is based on a relation between stream deflection and Mach Number which has been established experimentally for the flow in the limited supersonic regions on a number of airfoils. If this relation is assumed to be generally valid, it indicates that the Mach Number increase above unity for a given deflection is about one-third of that given by simple wave theory. An analysis of possible deflections on airfoils of various thicknesses indicates that deflections corresponding to local Mach Numbers of the order of 1.5 or higher are unlikely except at incidences of the order of 5° or more and then most probably on thick wings rather than on thin wings.

Theoretical Pressure Distributions for a Thin Airfoil Oscillating in Incompressible Flow. E. E. Postel and E. L. Leppert, Jr. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 486–492, figs. 7 references.

Formulas are derived for the theoretical pressures acting on a thin airfoil and aileron combination oscillating with harmonic motion of small amplitude in incompressible flow. The pressure distribution is calculated and tabulated for several representative values of the frequency parameter $1/k$ for airfoil translation, for airfoil rotation about the quarter-chord, and for hinged-surface flapping motions. The curves plotted from these data make it possible to compare the theoretical with the experimentally determined pressures and thus point the way to an empirical modification of the two-dimensional coefficients which may make possible a modification of theory. Equally important is the possibility of comparing three-dimensional experimentally determined pressures with present strip-theory methods of estimating three-dimensional effects.

Low-Drag and Suction Aerofoils. Sydney Goldstein. *Aircraft Engineering*, Vol. 20, No. 231, May, 1948, pp. 128–133, illus., figs.

Letter to the Editor. Alan Pope. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, p. 496.

A demonstration of a phenomenon noted by S. Goldstein in "Low Drag and Suction Airfoils": that more than a direct decrease in drag followed from the drawing off of the boundary layer and re-energizing it. From the demonstration it is stated that the theoretical minimum horsepower to overcome profile drag is not that which would be needed with 100 per cent laminar, boundary-layer flow but one-half of that amount.

Two-Dimensional Unsteady Lift Problems in Supersonic Flight. Max. A. Heaslet and Harvard Lomax. *U.S., N.A.C.A., Technical Note No. 1621*, June, 1948. 26 pp., figs. 7 references.

The variation of pressure distribution is calculated for a two-dimensional supersonic airfoil either experiencing a sudden angle-of-attack change or entering a sharp-edged gust. From these pressure distributions the indicial lift functions applicable to unsteady lift problems are determined for the two cases. Results permit the determination of maximum increment in lift coefficient attained by an unrestrained airfoil during its flight through a gust. As an application of these results, the maximum altitude for safe flight through a specific gust is calculated for a particular supersonic wing of given strength and wing loading.

Velocity Distributions on Symmetrical Airfoils in Closed Tunnels by Conformal Mapping. W. Perl and H. E. Moses. *U.S., N.A.C.A., Technical Note No. 1642*, June, 1948. 58 pp., figs. 7 references.

Conformal mapping methods developed by W. Mutterperl are adapted and applied to the calculation of the constraining effect of tunnel walls on the ideal zero-lift flow past arbitrary symmetrical airfoils. Results are compared with those of the conventional first-order image theory, of Goldstein's second-order image theory, and of a stream-filament theory with approximate allowance made for the curvature of the streamline. The local construction corrections obtained by the Goldstein second-order image theory are in better agreement with those calculated by conformal mapping than with those calculated by first-order image theory.

Air Power (43)

All Jet-Fighter Air Force; U.S. Air Policy and Fighter Development. *Flight*, Vol. 53, No. 2059, June 10, 1948, pp. 639, 640.

The Air Strategy of the British Commonwealth. Norman Macmillan. *Aeronautics*, Vol. 19, No. 1, June, 1948, pp. 58–62, 65, 66, maps.

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The Dutch Aircraft Industry. A. A. Hoehling. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 68, 71, illus.

Flight in Nature and in Human Society. M. J. B. Davy. *Royal Aeronautical Society, Journal*, Vol. 52, No. 449, March, 1948, pp. 323–326. 5 references.

Airplane Design & Description (10)

A Rocket Drive for Long Range Bombers. E. Sänger and J. Bredt. (*Deutsche Luftfahrtforschung, Untersuchungen und Mitteilungen Nr. 3538*, August, 1944.) *U.S., Bureau of Aeronautics (Navy Dept.), Translation No. CGD-32.* 174 pp., illus., diagrs. 25 references.

A study of rocket-propelled aircraft and their employment in long-range bombing operations. The self-contained power plant can operate at the outer limits of the earth's atmosphere and can attain supersonic velocities. The maximum thrust that in theory can be obtained from fuel combinations that have a maximum concentration of energy per unit mass is limited only by the thermal characteristics of the coolant, the materials of the combustion chamber and the exhaust nozzle, and the ability of the structures to withstand the pressures in the combustion chamber. The design of a hypothetical 10-ton aircraft is developed. Its aerodynamic characteristics are calculated throughout the various ranges of velocity and air density at which it will operate. These calculations are used to obtain the optimum climb path and thrust duration with assisted, catapult, and unassisted take-off. After initial climb the aircraft travels in an orbit around the earth in a supersonic glide to its target. When its velocity becomes subsonic, the altitude has decreased so that aerodynamic factors once again act and determine its glide and its landing. The flight path of the bombs that are released at altitudes in the vicinity of 150 km. at supersonic velocities is calculated in a manner similar to that of the aircraft. Various bombing tactics and methods of operational employment are treated in detail. The design of the jet engine, analysis of its thermodynamic characteristics and efficiencies, and the detailed evaluation of rocket fuels and the handling of liquid oxygen is based on work at the Technische Hochschule in Vienna in 1933–1934 and at the Trau Aeronautical Testing Station (Austria) in 1939. The report is an abstract of the results of investigations of long-range military rocket aircraft made during 1937–1941. It was originally to be part of a second volume of *Rocket Flight Technique* by E. Sänger.

The Dawn of the Supersonic Age. Hugh L. Dryden. *U.S. Air Services*, Vol. 33, No. 6, June, 1948, pp. 11–14, 24. (An address.)

General observations, technical problems of supersonic piloted aircraft, power plants, stability and control, military and commercial implications, and specialization and coordination in aeronautical engineering.

Can We Have a Universal Vehicle? William B. Stout. *Flying*, Vol. 42, No. 6, June, 1948, pp. 31, 56, 58, illus.

Increased utility should be the object of personal-aircraft design. Unconventional aircraft, such as roadable airplanes and designs using controllable wings and wings suspended on springs may indicate future trends.

Why Britain Is Turning to Airfreighters. S. A. Kreis. *Air Transportation*, Vol. 12, No. 4, April, 1948, pp. 20, 21, illus.

Size in Relation to Air Transport. Arthur Gouge. *The Aeroplane*, Vol. 74, No. 1930, June 4, 1948, pp. 674–678, figs. (Extended summary of a paper.)

Is the Air-Bus the Answer? Frank Tinsley. *Air Trails Pictorial*, Vol. 30, No. 4, July, 1948, pp. 39–41, 116–118, illus. A proposed design with a detachable main fuselage section, which can be used as a trailer passenger bus to bring passengers from city terminal to airport.

Let's "Imagineer" a Roadable. William B. Stout. *Flying*, Vol. 43, No. 1, July, 1948, pp. 33, 62, 64, illus.

For Greater Safety. *The Aeroplane*, Vol. 74, No. 1929, May 28, 1948, p. 651, illus.

Details of installation and manufacture of the Cimatrol flexible-bag fuel tank. The flexible synthetic-resin container can assume, in case of a crash, the shape of distorted tank bays without rupturing. Further fire protection for ordinary crash conditions can be obtained with the C.I.M.A. self-sealing tank covering. Both products are manufactured by Fireproof Tanks, Ltd.

Navion's Selective Two-Control System. *Aviation Week*, Vol. 48, No. 20, May 17, 1948, p. 18, illus., diagr.

Napier Cowling Fastener. *Flight*, Vol. 53, No. 2055, May 13, 1948, p. 534, illus.

German Landing Gear; Design and Testing. P. H. Watson and S. A. Makovski. (*Gt. Brit., British Intelligence Objectives Subcommittee, Report No. 251.*) *Aircraft Engineering*, Vol. 20, No. 231, May, 1948, pp. 134–136, 150, figs. (*See* AER 5/47:47.)

The Track Landing Gears' Future. *Plane Facts*, Vol. 5, No. 5, May 1948, pp. 10, 11, figs. Comparison of the frontal drag area, runway load pressure, and load distribution area of single- and multiple-tire landing gears with those of the Firestone continuous-track landing gear.

Why Cross-Wind Landing Gear? O. W. Loudenslager. *Aviation Week*, Vol. 48, No. 23, June 7, 1948, pp. 21, 22, 24, figs.

A brief résumé of the use of castering landing gear and the advantages it provides to military, commercial, and private aviation. The design and operation of the Goodyear cross-wind landing gear and a list of the aircraft for which it has been certified are included.

The Crosswind Gear. Leighton Collins. *Air Facts*, Vol. 11, No. 6, June 1, 1948, pp. 31–37, illus. The technique of taxiing, taking off, and landing airplanes equipped with castering landing gear.

Goodyear Cross-Wind Wheels. *Shell Aviation News*, No. 119, May, 1948, p. 24, illus., diagrs.

Beneficant Bigness; Some Views on British and American Transport Trends. *Flight*, Vol. 53, No. 2055, May 13, 1948, pp. 518–521, illus.

Fours into London; The Four-Engined Aircraft That Dominate Air Approaches to London. *Flight*, Vol. 53, No. 2059, June 10, 1948, pp. 633, 634, 637, illus.

Transports for Peace and War; A. Hastings and Hermes Melange: Deliveries From Radlett. *Flight*, Vol. 53, No. 2055, May, 13, 1948, pp. 523–526, illus.

Secrets of Russian Jets Revealed. *Aviation Week*, Vol. 48, No. 24, June 14, 1948, pp. 14, 15, illus. Descriptions and sketches of the Russian DFS 346 jet fighter-research airplane, an Iliushin four-jet bomber, a Tupelov twin-jet bomber, and a Mikoyan jet fighter.

Chronicles of Jet Propulsion. X, XI—United Kingdom (Continued). *The Aeroplane Spotter*, Vol. 9, No. 213, 214, May 15, 29, 1948, pp. 118; 130; illus.

New Shapes in the Air: The Gloster Meteor Trainer and the Lockheed TF80-C Shooting Star. *The Aeroplane Spotter*, Vol. 9, No. 214, May 29, 1948, p. 125, illus.

Designed for Freight: Fairchild (C-82) Packet and Curtiss-Wright CW-32. *Shell Aviation News*, No. 120, June, 1948, pp. 20, 21, illus. With table of direct operating costs of the Fairchild C-82.

New Shapes in the Air: The De Havilland DHA-3 Drover and the Gloster E.1/44. *The Aeroplane Spotter*, Vol. 9, No. 213, May 15, 1948, pp. 112, 113, illus., diagrs.

The Aérocentre NC-1070 Ship Plane. *Air Reserve Gazette*, Vol. 10, No. 6, June, 1948, p. 193, illus., diagrs.

Aeronca Sedan Simple to Fly. Ronald A. Keith. *Canadian Aviation*, Vol. 21, No. 6, June, 1948, pp. 26, 27, 76, illus.

Future Development of the (Airspeed) Ambassador; Performance Expectations of a Design for Long-Term Use. *de Havilland Gazette*, No. 44, April, 1948, p. 16, illus.

A for Ambassador (Airspeed). *Aeronautics*, Vol. 19, No. 1, June, 1948, pp. 44–47, illus.

New Type Bristol 170; Military Version; A Made-to-Measure Trooper/Freighter. *Flight*, Vol. 53, No. 2057, May 27, 1948, pp. 586, 587, illus., diagrs.

New Bristol Type 170 (Transport). *Shell Aviation News*, No. 118, April, 1948, pp. 20, 21, illus.

Canadair Presents the Canadair Four. Ira F. Angstadt. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 26, 27, 104, illus., diagr.

Chrislea Super Ace (Series II). *Flight*, Vol. 53, No. 2057, May 27, 1948, pp. 567–570, figs., cutaway drawings.

Jeep on the Wing (Convair L-13). *Southern Flight*, Vol. 29, No. 6, June, 1948, pp. 12, 13, illus.

Original Ideas in Air Transport Feature Convair-Liner (240) Design. *Canadian Aviation*, Vol. 21, No. 6, June, 1948, pp. 24, 25, 75, illus.

The De Havilland Dove (Two 340 h.p. de Havilland Gipsy Queen 70 Series Engines). *The Aeroplane*, Vol. 124, No. 1929, May 28, 1948, pp. 638–640, cutaway drawings.

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Australian Designed de Havilland "Drover" (Three-Engined Transport). *Shell Aviation News*, No. 120, June, 1948, p. 19, illus.

Australia's (de Havilland) Drover. *de Havilland Gazette*, No. 44, April, 1948, p. 5, illus., diagrs.

Douglas Skyrocket: Research at Sonic Speed. *Shell Aviation News*, No. 120, June, 1948, pp. 22, 23, illus., diagrs., fig.

"Junior" in the Air; Fairey's Ultra-Light Design Handled in Rough Weather; Performance on 35 H.P. Maurice A. Smith. *Flight*, Vol. 53, No. 2059, June 10, 1948, pp. 623, 624, illus., diagrs.

Flying the Fairey Primer. James Hay Stevens. *Air Reserve Gazette*, Vol. 10, No. 6, June, 1948, pp. 190–192, 216, illus., diagrs.

Jet Trainer (Gloster Meteor Mk. VII). *Flight*, Vol. 53, No. 2056, May 20, 1948, pp. 541–543, illus.

Fury Trainer (Hawker Sea Fury T. Mk. XX); Dual-Control Version of a Modern Piston-Engined Fighter; A Periscopic Gunsight. *Flight*, Vol. 53, No. 2058, June 3, 1948, pp. 595, 596, illus., diagr.

American Jet Trainer; Versatility of Lockheed Shooting Star TF-80 C: Armament Installed. *Flight*, Vol. 53, No. 2054, May 6, 1948, p. 495, illus.

New Flying Boat Design Announced (Martin XP5M-1 Twin-Engined Patrol Flying Boat). *The Martin Star*, Vol. 7, No. 5, June, 1948, p. 7, illus.

XF-86 (North American) Flies Faster Than Sound. Robert McLarren. *Aviation Week*, Vol. 48, No. 24, June 14, 1948, pp. 11, 12, illus.

Tamed Cub. William Winter. *Flying*, Vol. 42, No. 6, June, 1948, pp. 18, 66, 68, illus. The N.A.C.A. spinproof and stall-resistant modification of a 50-hp. Piper Cub.

Scottish Aviation's Prestwick Pioneer. *Shell Aviation News*, No. 119, May, 1948, pp. 22, 23, illus., diagr. Includes diagram showing operation of flaps and slats.

The Rocket-Firing Republic (F-84) "Thunderjet." *U.S. Air Services*, Vol. 33, No. 6, June, 1948, p. 15, illus.

Scandia (Saab) Discussed; A Swedish D.C. 3 Replacement With Outstanding Performance; "In the Air" Impressions. Maurice A. Smith. *Flight*, Vol. 53, No. 2058, June 3, 1948, pp. 607–613, illus., cutaway drawing.

Airports & Airways (39)

The Siting of Airports. W. J. Cozens. *Airports & Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 421–424. (Extended summary of a paper.)

Approach Lighting for Airports; Visual Aids in Low Visibility; R.A.E. Horizon Bar System at Farnborough. *Modern Transport*, Vol. 109, No. 1518, May 1, 1948, p. 9.

Funds for Small Airports. John H. Frederick. *Southern Flight*, Vol. 29, No. 6, June, 1948, p. 26. Progress of the 1948 National Airport Plan.

High Intensity Approach Lighting. E. S. Calvert. *Shell Aviation News*, No. 118, April, 1948, pp. 15–19, diagrs. 1 reference. Report on the R.A.E. horizon-bar system.

What's Ahead for Airport Lighting. William Kroger. *Aviation Week*, Vol. 48, No. 22, May 31, 1948, pp. 18, 21–25, illus., figs.

Descriptions of the runway and approach lights manufactured by Crouse-Hinds Company, Westinghouse Electric Corporation, Revere Electric Manufacturing Company, American Gas Accumulator Company, and the Line Material Company. Includes light distribution of each type of runway light and the various approach lighting systems under test.

Lighted Glide-Path for Small Airports; Four-Unit System Costing $1500. *Aviation Week*, Vol. 48, No. 21, May 24, 1948, pp. 32, 35, illus.

How Arcata Lighting Systems are Flight Tested. C. W. Grimes and B. B. Clark. *Airports and Air Carriers*, Vol. 13, No. 6, June, 1948, pp. 8–10, illus.

American's New Chicago Hangar. *Airports and Air Carriers*, Vol. 13, No. 6, June, 1948, pp. 22, 23, illus.

Airport Buildings. J. W. S. Brancker. (Brancker Memorial Lecture 1948.) *Institute of Transport, Journal*, Vol. 22, No. 18, April-May, 1948, pp. 637–644, figs.

Air Marking for Texas. M. W. Hunter. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 40, 41, 98, 99, illus.

Airports of the World: Orly, Post-War Major Airport for Paris. *Airports & Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 417–419, illus., figs.

Third Progress Report on London Airport. *Airports & Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 403–406, illus. Includes construction statistics up to March 31, 1948.

Berth 50; BOAC'S New Marine Base at Southampton. *Airports and Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 425–427, illus.

Friendly Flames; The Blackbushe Fido on Test; For Emergency Use Only; Ministry Reserve Right of Investigation. *Flight*, Vol. 53, No. 2055, May 13, 1948, pp. 515, 516, illus.

New Conduit Jacking Method. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, p. 15, diagr.

Protecting Airports Against Electrostatic Fires. Robin Beach. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, pp. 8, 9, illus. 2 references.

How Britain Controls Winter Air Traffic. Howard Pearce. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, p. 24, illus.

All-Weather Flying (31)

ICE PREVENTION

An Investigation of a Thermal Ice-Prevention System for a Cargo Airplane. IX—The Temperature of the Wing Leading-Edge Structure as Established in Flight. Bernard A. Schlaff and James Selna. *U.S., N.A.C.A., Technical Note No. 1599*, June, 1948. 44 pp., illus., diagr., figs. 15 references.

Data were obtained at various normal operating conditions and also at controlled conditions selected to determine the effects of heated-air temperature, heated-air flow rate, air speed, and altitude on the structure temperatures. The results of the investigation indicate that: (1) the structure temperatures that prevail in a thermal ice-prevention system are of sufficient magnitude to require some consideration in the design of stressed members, and (2) heated-air temperature is the primary variable affecting the structure temperatures.

Effects of Ice Formations on Airplane Performance in Level Cruising Flight. G. Merritt Preston and Calvin C. Blackman. *U.S., N.A.C.A., Technical Note No. 1598*, May, 1948. 37 pp., illus., figs. 7 references.

Maximum loss in propeller efficiency encountered was 19 per cent. During 87 per cent of the propeller icing encounters, losses of 10 per cent or less were observed. Ice formations on all components of the airplane, except the propellers, during one icing encounter resulted in an increase in parasite drag of the airplane of 81 per cent. The control response of the airplane in this condition was marginal.

Anti-Icing Developments at Avro. *Aircraft and Airport*, Vol. 10, No. 5, May, 1948, pp. 28–30, diagrs.

Aviation Medicine (19)

Visual Examination of Flyers Returned From Combat. Henry A. Imus. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 62–93, figs. 80 references.

In order to evaluate the visual portion of the flight physical examination, 250 Naval aviators recently returned from combat or operational tours of duty were given a complete eye examination, and, in addition, measures of refraction, aniseikonia, several other tests of depth perception, and scores on a visual classification device, the Bausch and Lomb Ortho-Rater, were obtained. The subjects presented superior scores of visual acuity and near vision, low refractive errors, mild degrees of aniseikonia, and normal variations of heterophoria. Their stereoscopic depth perception was no better than an average population having normal vision. The compensatory fusional innervations varied from extremely poor to very high, and the amplitude of accommodation varied widely as compared with that expected according to standard age tables. Those subjects who were selected originally for superior visual capacity retained their superiority. Their visual acuity, however, was considerably above the passing standard of 20/20, whereas their stereoscopic depth perception was not outstanding.

Observations of an Ophthalmic Examiner. Benjamin J. Wolpaw. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 94–99.

Aviation Medicine Research (Aviation Medicine Section of the R.A.A.F. Directorate of Medical Services). *Aircraft*, Vol. 26, No. 8, May, 1948, pp. 20, 21, 44, illus.

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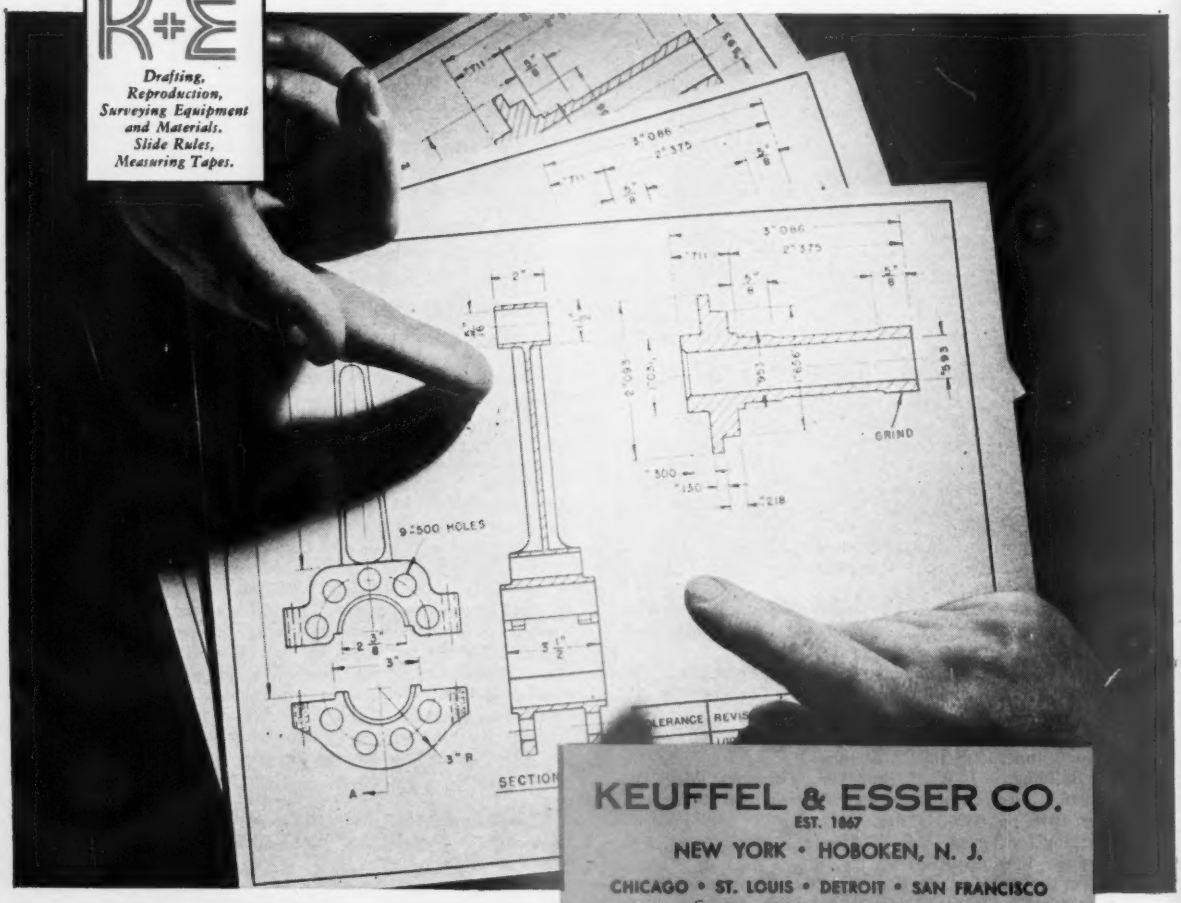

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Deaths in Air Evacuation. Joseph N. Schaeffer. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 100–107.

Flight Histories and Factors Related to Flight Histories of a Group of Physically Deficient Aircraft Pilots. Dean R. Brimhall. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 108–114, 119.

The Aviation Training Jacket. R. C. Hovde. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 120–123.

A permanent and uniform detailed record giving a cumulative day-by-day account of a student's absorption and adjustment to the flight-training program. This record is to be used in conjunction with the U-BAG comparative grading system, which will attempt to establish uniform grading and reduce to a minimum the personal element.

Development of Chemical Oxygen Generators for Use in Aircraft. G. A. Millikan and J. R. Pappenheimer. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 118, 119.

Aero Medicine in the Spotlight as Planes Fly Faster, Higher. Ronald A. Keith. *Canadian Aviation*, Vol. 21, No. 6, June, 1948, pp. 22, 23, 72, 74, 75, illus.

The facilities, research projects, and past activities of the R.C.A.F. Institute of Aviation Medicine. Brief note is included on the agenda of the Aero Medical Convention held at Toronto in 1948.

The Application of War Research to Civil Aviation Medicine. Herman S. Wigodsky. *Journal of Aviation Medicine*, Vol. 19, No. 2, April, 1948, pp. 115–117, 123.

Electronics (3)

Statistical Methods in the Design and Development of Electronic Systems. L. S. Schwartz. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 5, May, 1948, pp. 664–670, fig.

Telecommunications Research at Malvern (Telecommunications Research Establishment, Ministry of Supply). *The Aeroplane*, Vol. 74, No. 1930, June 4, 1948, pp. 662, 663, illus.

Flare-Out System for Instrument Landing. C. B. Pratt, H. H. Giesecke, and S. Knemeyer. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 11, June 1, 1948, pp. 9–12, figs.

Analysis of contact landings showed that the typical path of descent of a C-47 airplane closely followed an exponential curve. In order to investigate the possibility of obtaining an exponential flare-out in a complete instrument landing, one grid of a double triode was connected to the output of the radio altimeter. The other grid was connected through a parallel reactance-capacitance circuit to the ground, and the two grids were connected by a resistor. The tube operated as a cathode follower so that the deflection of a meter in the cathode circuit was proportional to the voltage differences on the grids. Since the reactance-capacitance circuit discharges as an exponential function and since the pilot so varied the rate of descent to keep the indicator needle centered, thus balancing the output voltage of the radio altimeter with the discharging reactance-capacitance circuit, the aircraft followed an exponential path. Smooth touch-downs were obtained with this equipment.

Radio: Guide or Gadget? Charles J. Melville. *Air Facts*, Vol. 11, No. 6, June 1, 1948, pp. 22–30, illus. The installation of ILS equipment and automatic direction finder in a Ryan Navion and an account of its use.

Low-Cost ADF Installation. Lee Brady. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 74, 75, illus., diagr. Installation of war-surplus equipment.

New VHF Omni Ranges. *Airports and Air Carriers*, Vol. 13, No. 6, June, 1948, p. 16, illus.

The Hazeltine Lanac System of Air and Marine Navigation. Knox McIlwain and Charles J. Hirsch. *Navigation*, Vol. 1, No. 10, June, 1948, pp. 210–216, figs. 3 references.

A comprehensive navigation, anticollision, traffic-control, and rescue system. It uses two low-power pulse transmitters and receivers, an interrogator-responder, and replier or transponder. The interrogator of the aircraft or vessel transmits a series of pulses coded by a combination of frequency and time separation between successive pulses to interrogate nearby beacons. The Morse-coded reply pulses from the beacon are picked up by the interrogator and displayed either on a plan-position-indicator oscilloscope or on meters as relative bearing, true azimuth, and distance to the beacon. For obstacle and collision avoidance and in traffic control all craft are coded to answer only vehicles at their own altitude and use oscilloscope display.

Keeping in Touch; New British Two-Channel VHF Equipment for Light Aircraft. *Flight*, Vol. 53, No. 2055, May 13, 1948, pp. 532, 533, illus.

The Ekco Lightweight Radio for Civil Aircraft. *Airports & Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 415, 416.

Some Fundamental Considerations Concerning Noise Reduction and Range in Radar and Communication. Stanford Goldman. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 5, May, 1948, pp. 584–594, figs. 2 references.

The mathematical theory shows that the probability of a signal being noise rather than information is unaffected by the distribution of the signal energy in time among the frequencies of the band or the duration of transmission. It depends only on the total of the energy of the desired signal and the background "white" noise field. If the average power of a radar signal remains constant, a reduction of the pulse-repetition rate increases the signal energy in each pulse and, hence, the signal-to-noise ratio. Since the degradation of a signal during reception is less for large ratios, radar range increases as the pulse-repetition rate increases. Noise reduction in communication systems can be obtained by expanding the band width so that it will carry selectivity information that makes the signal of the particular type or shape to which a prearranged detector is especially sensitive. The number of times that the message information is repeated in the frequency spectrum determines the reduction in signal-to-noise ratio.

Ionosphere Reflections Recorded Mechanically by Means of a Repetition Frequency Converter. W. Stoffregen. *Journal of Applied Physics*, Vol. 19, No. 5, May, 1948, pp. 487–490, illus., figs. 6 references.

A method of converting the high repetition frequency used by echo sounding to a lower value by means of a converter between the receiver and the recorder. The method is adapted to recordings of radio echoes from the ionosphere, in which case the repetition frequency of 50 cycles per sec. of the pulse transmission after reception is converted into a repetition frequency of $^1/_2$–$^1/_5$ cycles per sec. before being supplied to the recorder. Ionosphere echoes having a delay of the order of milliseconds and a pulse width of about 20–100 μsec. may thus be recorded mechanically. The principle of repetition frequency conversion described may also find applications in recording ultrasonic or radar reflections.

Restricted-Range Sky-Wave Transmission. J. E. Hacke, Jr., and A. H. Waynick. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 6, June, 1948, *Waves and Electrons Section*, pp. 787–793, figs. 7 references.

It should be feasible to restrict considerably the range within which radio signals may be received after reflection from the *E* layer of the ionosphere. This is accomplished by proper choice of operating frequency and by using a relatively simple directive array beamed vertically upward. Other types of arrays and operating frequencies are compared.

An Approach to the Approximate Solution of the Ionosphere Absorption Problem. James E. Hacke, Jr. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 6, June, 1948, pp. 724–727, figs. 5 references.

A series of parabolic approximations was obtained for portions of the Chapman distribution and its product with the collisional frequency. By their use an improved approximate solution was found for the "true" and the group height of reflection, and for the absorption in the region, under conditions of vertical incidence, wave frequency greater than the maximum collision frequency and less than the critical frequency for the region, and with the earth's magnetic field neglected. These improved analytic approximations are compared with the usual parabolic approximation and with numerical approximations obtained by other workers.

Equipment for Servicing and Testing Electronic Devices. *The Electronics Forum*, No. 8, December, 1947, pp. 24–26, Discussion, pp. 26–28.

High Voltages in Electronics. Walter E. Peery. *Machine Design*, Vol. 20, No. 6, June, 1948, pp. 123–127, diagrs., figs. Formulas and charts for the correct spacing between conductors for the prevention of sparking and corona effects.

Multifrequency Bunching in Reflex Klystrons. W. H. Huggins. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 5, May, 1948, pp. 624–630, figs. 3 references.

General expressions for the power and the electronic admittance obtained by extending Webster's simple bunching theory to include the simultaneous oscillation of a reflex klystron at two or more frequencies explain the intermodulation effects that have been observed in practice. In the presence of a vigorous low-frequency oscillation, oscillations may be obtained simultaneously at a higher frequency if the transit time is $(N + 1/4)$ radio frequency cycles. The "normal" oscillations obtained for $(N + 3/4)$ radio frequency cycles are usually unstable in the presence of the flow-frequency oscillation. The power and electronic admittances that are obtained when the oscillation frequencies are exactly in the same ratio as two integers are analyzed.

Recent Developments in Frequency Stabilization of Microwave Oscillators. W. G. Tuller, W. C. Galloway, and F. P. Zaffarano. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 6, June, 1948, *Waves and Electrons Section*, pp. 794–800, figs. 2 references.

A modification of the stabilization system of R. V. Pound to develop it into an engineered system, free of involved tune-up procedure and dependence on the uncontrolled characteristics of microwave tubes and crystals.

Slip Rings and Brushes for Constant Electrical Resistance. Francis J. Dutee, Franklyn W. Phillips, and Richard H. Kemp. *Product Engineering*, Vol. 19, No. 6, June, 1948, pp. 129–133, illus., figs. Comparison of electrical contact resistance characteristics of 24 combinations of slip rings and brushes for transmitting low electric power such as that required for strain gages of the resistance type.

The Economic Dimensioning of Small Transformers. S. Silleni. (*Tecnica Italiana*, Vol. 11, No. 5–6, September–December, 1947, pp. 231–235.) *The Engineers' Digest*, Vol. 5, No. 4, May–June, 1948, pp. 214–216, diagr., figs.

On the Time Function of the Radiation of Short Spark Discharges (Project No. XE-13). Heinz Fischer and Martin Reger. *U.S., Air Force, Technical Report No. F-TR-1178-ND (GS-USAF Wright-Patterson Air Force Base No. 86)*, May, 1948. 13 pp., illus., figs. 12 references.

The results of preliminary investigations of the time function of the radiation and the current of maximum-intensity sparks of minimum duration. Maximum radiation density lagged behind maximum current intensity and took place at a time when expansion of the spark channel caused a considerable reduction in the energy density and a cooling of the spark plasma. The expansion and subsequent cooling of the channel increases the radiant surface and the percentage of long-wave radiations to give an increase in the intensity of the total radiation emitted by the spark.

Engineering Practices & Aids (49)

Perspective Drawing. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 208–210, illus., diagrs.

A machine developed at the Bristol Aeroplane Company, Ltd., and manufactured by Isometric Projections, Ltd., for the semi-mechanical conversion of engineering drawings to perspective views. The double-pantograph linkage reproduces vertical and horizontal lines in different ratio to permit the development of drawings in parallel perspective.

Patents and the Engineer. I. H. A. Toulmin, Jr. *Product Engineering*, Vol. 19, No. 6, June, 1948, pp. 112–128, illus., figs. Patent procedure, Patent Office rules, and methods for testing and protecting patentable inventions.

Equipment

A Few Notes on Saab's Production of Aircraft Equipment. Torsten Faxén. *Saab Sonics*, No. 2, April–June, 1948, pp. 4–7, 25, diagrs.

Organization, essential requirements, design and construction, manufacture, testing and inspection, and standards.

ELECTRICAL (16)

The Stratocruiser (Boeing 307) DC Power System. *Boeing Service Guide*, No. 9, June, 1948, pp. 2–8, illus., diagrs.

Aircraft Transformers. *General Electric Company, Apparatus Department, Catalog*, May, 1948. 27 pp., illus., diagrs., tables.

Air-Driven Spinners. L. W. Wightman. *Machine Design*, Vol. 20, No. 5, May, 1948, pp. 121–125, illus., diagrs., figs.

Descriptions of the successive experimental designs that were tested in the development of a spinner that could be loaded rapidly and would spin commutators of aircraft motors at speeds exceeding those met in practice. A direct-drive air turbine was used to obtain speeds as high as 60,000 r.p.m. The large clearance of the air bearings allows the rotating parts to spin around their own center of gravity, thus eliminating vibrations that might be caused by unbalance.

The Effect of High-Resistance Ignition Cable on the Erosion of Spark-Plug Electrodes. Clyde C. Swett, Jr., and Franklin A. Rodgers. *U.S., N.A.C.A., Memorandum Report No. E5121 (Wartime Report No. E-267)*, September, 1945. 9 pp., figs. 1 reference.

HYDRAULIC & PNEUMATIC (20)

Hydraulic Remote Control. R. Westbury. *The Aeroplane*, Vol. 74, No. 1926, May 7, 1948, pp. 531–533, illus., figs., diagrs.

The Hobson Remoter system and its installation on the Armstrong Whitworth A.W. 52. The signal of the pilot's control lever acts on the transmitter unit, which is a variable pressure reducing valve. The hydraulic pressure signal in turn acts on the receiver unit, which controls the flow of high-pressure fluid to the jack. This hydraulic transmission system eliminates mechanical linkage between the cockpit and the operating unit and permits the simultaneous and synchronous operation of the independent sections of flaps.

Inverted Relief Valves. H. G. Conway. *Machine Design*, Vol. 20, No. 5, May, 1948, pp. 129–133, diagrs., figs.

Design and characteristics. The force between the valve and the valve seat remains directly proportional to the fluid pressure until the related pressure of the valve is reached. The absence of a range, just prior to opening, in which the valve is sensitive prevents seeping or premature dribbling. The piston action of the valve seat suppresses valve vibration and noise.

The Individual Hydraulic Systems. *Boeing Service Guide*, No. 8, May, 1948, pp. 2–8, diagrs.

A general discussion of the individual hydraulic systems in Boeing aircraft—in the normal-brake, emergency-brake, nose-wheel steering, windshield-wiper, and the rudder-boost hydraulic systems.

Flight Safety & Rescue (15)

A Study of Serious and Fatal Accident Records During 1939 and 1940. Raymond Franzen and Dean R. Brimhall. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 77*, May 1948. 63 pp., tables.

An evaluation of C.A.A. noncarrier accident record files for 1,163 accidents that occurred during 1939 and 1940. In 65 per cent of the fatal accidents studied, an inadvertent stall preceded the crash, and half of the stalls had been incident to the improper execution of a turn. Since this high percentage could not be attributed to defects on record for the pilots, it was assumed to be due to inadequate instruction. Comparison was made between a sampling of C.A.A. pilots and a sampling obtained during other research in California. The differences among pilots having accidents and accident-free pilots are discussed in terms of elements of information pertaining to pilot history.

Towards Greater Air Safety. W. A. Hannan. *Flight*, Vol. 53, No. 2056, May 20, 1948, pp. 556, 557, 559.

An analysis of data on fatal accidents published in *Flight* during the first 4 months of 1948 shows that the largest individual total consists of lives lost at sea. This could have been reduced by improved navigational aids and more accurate weather forecasting. The next largest total, lives lost through fires after crash landing, could be minimized by the adoption of crashproof fuel tanks.

The ABC's of Arctic Survival. U.S., Air Force, Alaskan Air Command. *U.S., Air Services*, Vol. 33, No. 6, June, 1948, pp. 16, 18, 25, illus.

Correspondence: Towards Greater Air Safety. *Flight*, Vol. 53, No. 2059, June 10, 1948, pp. 647, 648.

Flight Testing (13)

New Aeronautical (Flight) Test Facilities at General Electric. *Plane Facts*, Vol. 5, No. 5, May, 1948, pp. 22, 23, 30, illus.

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A Vampire Fighter Regains Altitude Record for Britain. *de Havilland Gazette*, No. 44, April, 1948, pp. 2, 3, illus.

Fuels & Lubricants (12)

Quantitative Analysis of Ternary Mixtures of Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene by Ultraviolet Spectrophotometry. Alden P. Cleaves, Mildred S. Carver, and Robert R. Hibbard. *U.S., N.A.C.A., Technical Note No. 1608*, June, 1948. 22 pp., figs. 7 references.

A method for quantitative analysis on the basis of ultraviolet absorption in the region from 3,100 to 3,300Å. Synthetic ternary mixtures were analyzed with an average error of 0.8 per cent of alkylnaphthalenes present.

Interrogation of Dr. Hans Friedrich Gold. Paul Cherney. *Combined Intelligence Objectives Sub-Committee, Item No. 1, 4 & 5, File No. 32-109*. 25 pp., figs. British Information Services, New York. $1.00.

Report of research at the Luftfahrtforschungsanstalt Hermann Göring, Volkenrode, on rocket fuels (with a list of specifications), an instrument for measuring the ignition lag of hypergols photoelectrically, and a method of stopping internal combustion engines. In experimental tests of this method, sufficiently severe knock was caused in an internal-combustion engine to stop it within 1 sec. and damage it sufficiently to warrant shop repair, by introducing methyl nitrate into the air intake in a concentration of 8 per cent.

The Knock-Limited Performance of Fuel Blends Containing Aromatics. IV—Data for *m*-Diethylbenzene, 1-Ethyl-4-Methylbenzene and *sec*-Butylbenzene Together With a Summarization of Data for 12 Aromatic Hydrocarbons. Carl L. Meyer and J. Robert Branstetter. *U.S., N.A.C.A., Advance Restricted Report No. E5D16a (Wartime Report No. E-231)*, April, 1945. 60 pp., figs. 4 references.

Flight and Test-Stand Investigation of High-Performance Fuels in Double-Row Radial Air-Cooled Engines. II—Flight Knock Data and Comparison of Fuel Knock Limits With Engine Cooling Limits in Flight. H. Jack White, Calvin C. Blackman, and Milton Werner. *U.S., N.A.C.A., Memorandum Report No. E4L30 (Wartime Report No. E-248)*, December, 1944. 36 pp., illus., figs. 10 references.

Additional Information Concerning the Fischer-Tropsch Process and Its Products. C. C. Hall and S. R. Craxford. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1722, Item No. 22*. 188 pp., figs. British Information Services, New York. $5.25.

Correlation of the Characteristics of Single-Cylinder and Flight Engines in Tests of High-Performance Fuels in an Air Cooled Engine. I—Cooling Characteristics. Robert W. Wilson, Paul H. Richard, and Kenneth D. Brown. *U.S., N.A.C.A., Memorandum Report No. E5J04 (Wartime Report No. E-271)*, October, 1945. 17 pp., figs. 4 references.

Flight and Test-Stand Investigation of High-Performance Fuels in Modified Double-Row Radial Air-Cooled Engines. I—Determination of the Cooling Characteristics of the Flight Engine. Milton Werner, Calvin C. Blackman, and H. Jack White. *U.S., N.A.C.A., Memorandum Report No. E5G09 (Wartime Report No. E-261)*, July, 1945. 55 pp., illus., diagrs., figs. 7 references.

Flight and Test-Stand Investigation of High-Performance Fuels in Modified Double-Row Radial Air-Cooled Engines. II—Flight Knock Data and Comparison of Fuel Knock Limits With Engine Cooling Limits in Flight. H. Jack White, Philip C. Pragliola, and Calvin C. Blackman. *U.S., N.A.C.A., Memorandum Report No. E5H04 (Wartime Report No. E-262)*, August, 1945. 61 pp., figs. 9 references.

A Correlation of the Effects of Compression Ratio and Inlet-Air Temperature on the Knock Limits of Aviation Fuels in a CFR Engine—II. Henry A. Alquist, Leon O'Dell and John C. Evvard. *U.S., N.A.C.A., Advance Restricted Report No. E6E13 (Wartime Report No. E-240)*, June, 1946. 40 pp., figs. 4 references.

Aid to Reliable Fuel Rating Emerges From CRC Test Work. Donald B. Brooks and Robetta B. Cleaton. *SAE Journal*, Vol. 56, No. 6, June, 1948, pp. 53, 54, figs.

An Evaluation of the Knock-Limited Performance of Triptane. Henry C. Barnett. *U.S., N.A.C.A., Memorandum Report No. E6B20 (Wartime Report No. E-276)*, March, 1946. 23 pp., figs. 11 references.

A Study of the Kinetics of Bearing Corrosion and Oil Oxidation: Correlation of Various Test Methods. Hugh R. Lehman and L. Kermit Herndon. *Ohio, University, Engineering Experiment Station, News*, Vol. 20, No. 1, February, 1948, pp. 45–52, figs.

A method of graphical analysis for the corrosion curves exhibited by the MacCoull Bearing Corrosion Tester. The specific reaction-velocity constant that is obtained obeys the Arrhenius equation relating the reaction-velocity constant to temperature. By use of this constant and by integrating a rate equation for bearing corrosion, curves are produced which accurately duplicate data curves and provide a way of correlating the many and varied oil-oxidation and bearing-corrosion test methods.

The Thixotropic Characteristics of Lubricating Oil Greases. L. W. McLennan and G. H. Smith. *American Society for Testing Materials, Bulletin*, No. 152, May, 1948, pp. 71–75, figs. 12 references.

Sodium-, calcium-, aluminum-, lithium-, and barium-base greases were worked in a mechanical grease worker and circulated through a closed system containing a capillary. Their penetration values, the power required to operate the grease worker, and pressure-drop readings across the capillary, when plotted against the length of time the greases were worked, showed that most lubricating oil greases, upon being subjected to mechanical working, break down in a regular manner and heal in a regular manner when allowed to remain undisturbed in storage. The introduction of the thixotropic characteristics in calculations of apparent viscosities of greases eliminates errors that have heretofore been observed. These results raise the question of the validity of the concept of yield point and offer a method by which the extent to which a grease will harden in storage may be predicted.

Research in Fuels and Lubricants; Shell Laboratory at Thornton. *Modern Transport*, Vol. 59, No. 1522, May 29, 1948, p. 7, illus.

Gliders & Gliding (35)

Ultimate Performance Possibilities of Sailplanes; Résumé of Symposium. Ben Shupack. *Aeronautical Engineering Review*, Vol. 7, No. 9, September, 1948, pp. 34–40, illus. 11 references.

The papers read at the joint meeting of the I.A.S. and the Soaring Society of America at Elmira, N.Y., on July 1, 1948, treated the performance and design of an ideal sailplane. Major interest was shown in the topics of cross-country performance, laminar wings, laminar boundary layer, reduction of aspect ratio, and the value of the glider in low-speed aerodynamic research.

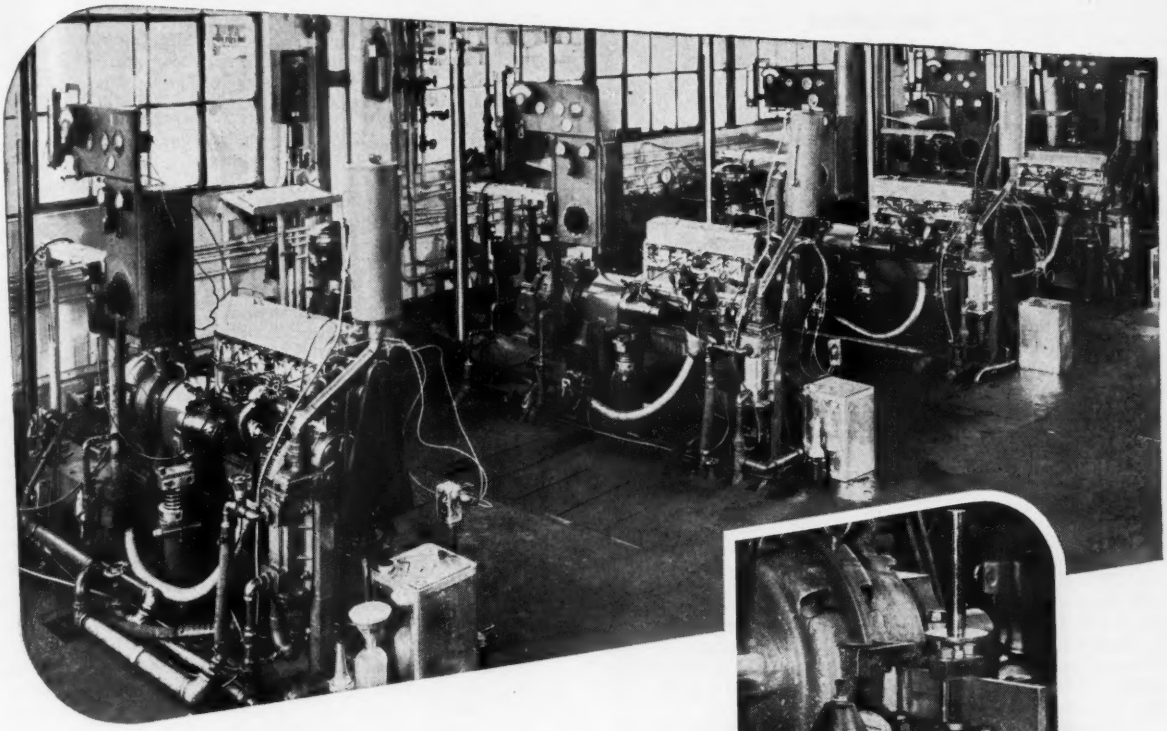
Impressions of the T21B (Slingsby Two-Seater Sailplane). Arthur Clark. *Air Reserve Gazette*, Vol. 10, No. 6, June, 1948, p. 196, illus.

Guided Missiles (1)

Guided Missiles. I—Their Evolution and Principles. A. R. Weyl. *The Aeroplane*, Vol. 124, No. 1929, May 28, 1948, pp. 641–643, illus., cutaway drawings.

Both the air-borne and the projectile type of guided missile require that flight path and destination be determined by a controller outside the missile. In both types control may either be preset or continuously applied by the external controller. In Germany, radio-controlled model aircraft had been flown in 1913, and a Sperry automatic pilot was demonstrated in France in 1914. In England, from 1915 to 1918, experiments were conducted on the radio control of modified conventional aircraft, and, although line-of-sight control was accomplished, pay loads and maneuverability were unsatisfactory. In 1934 a pilotless target biplane equipped with an R.A.E. automatic pilot was used successfully. In France, although no attempt had been made to realize the pulse-jet flying bomb suggested by René Lorin in 1910, experiments were undertaken in 1916 on the automatic stabilization of aircraft. In 1918 a Voisin pusher biplane made a radio-controlled flight of more than 1 hour, stabilized by a Sperry gyroscopic automatic pilot. By 1923, monitoring, telecontrol, and automatic landings had been accomplished.

Building Better Bullets at Navy's Inyokern Base. *Western Flying*, Vol. 28, No. 6, June, 1948, pp. 12, 13, illus.



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Installations

UNDERGROUND (32)

Aircraft Construction Under Ground. Hugo Bertler. *Saab Sonics*, No. 2, April–June, 1948, pp. 9–16, illus.

Rock premises in general. Advantages of placing war industries underground. Saab's underground workshops are blasted out of the rock at secure depth below the surface. A concrete structure of two floors is built into tunnels blasted out of the rock. Air-conditioning. Large quantities of heat must be removed. Mainly circulating air in the ventilation system. Fresh air from the outside, up to 120 cu.m. per hour per person, can be drawn in from the outside. Work may be carried on during a gas attack. The workshops are divided into some 20 sections, each having its air-conditioning set. The regulation of the temperature and moisture is effected automatically. The space between the rock and concrete building is employed as an evacuating duct. The cooling plant consists of two compressor sets with accessories. The water supply for the workshops is provided by two wells 100 m. in depth. Slight variations in the room temperatures. Lighting. Mixed lighting for general illumination. Meteorological clocks. Underground factories versus factories above ground.

Instruments (9)

A Pick-Up for the Measurement of Quasi-Static Angular Acceleration. L. Statham. *Review of Scientific Instruments*, Vol. 19, No. 6, June, 1948, pp. 381–384, diagr. 1 reference.

Design parameters for an angular accelerometer. The accelerometer incorporates an electrical sensing element that may be energized by dry-cell batteries and whose output may be connected directly to a recording galvanometer.

Development of an Air-Operated Force-Measuring System. A. A. Markson and R. S. Williams. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 271–278, illus., diagrs., figs.

Description of a force-measuring system that employs a nonmetallic flexible diaphragm as a frictionless null-deflection measuring piston. When a force is applied to the measuring diaphragm, a relay pilot valve automatically admits or exhausts air from the diaphragm chamber and acts as a null-point regulator of the diaphragm position. The balancing air pressure serves as a measure of the applied force. The system is stabilized by a viscous stabilizer that consists of two diaphragm chambers enclosed by flexible diaphragms, connected by a small orifice in the partition plate, and completely filled with a damping fluid. A detailed evaluation of the system and its probable errors is given.

Automatic Pilots. J. C. Owen. *Electrical Engineering*, Vol. 67, No. 6, June, 1948, pp. 551–561, figs.

A general exposition of the theory and operation of the automatic pilot. The basic servomechanism used in the directional gyro was stabilized and refined by the addition of a feed-back loop to modify the error signal by a correction proportional to the control-surface deflection and to keep the deflection proportional to the error. Lack of a damping inherent in the aircraft's design was compensated by the introduction of rate-of-displacement and acceleration signals. Suitable modification of these circuits resulted in the maneuvering automatic pilot which, when supplied with navigational parameters, provided complete flight-path control.

S.E.P.-I—The Smith's Electric Automatic Pilot. *The Air-Log* (Sydney), Vol. 9, No. 12, February, 1948, pp. 18, 20, 22, 24, 26, 27, cutaway drawings.

Ceramics May Serve in Turbines and Jets for Instruments. W. N. Harrison. *SAE Journal*, Vol. 56, No. 6, June, 1948, pp. 47–49, fig. (Summary of a paper: High-Temperature Ceramic Coatings for Molybdenum.)

A Capacitance Type Torquemeter. C. H. G. Mills. *Journal of Scientific Instruments*, Vol. 25, No. 5, May, 1948, pp. 151–156, figs.

The instrument described is intended primarily for the measurement of small dynamic torques of the order of 10 lb.ft. peak with an accuracy of ±5 per cent. The frequency response is sensibly flat over the range from zero to above 10 kc. The d.c. response enables static measurements to be carried out over short periods not exceeding $^1/_2$ hour, the limit being imposed by the zero drift of the instrument. The change of capacitance of the measuring head causes an oscillator to be frequency modulated. The frequency modulated signal is passed through a limiter stage to eliminate amplitude modulation components present in the signal because of resistance fluctuations at the slip-rings, by which the gage connections are made. A simple discriminator, fed from the limiter, is followed by one stage of d.c. amplification whose output is directly coupled to a cathode-ray tube and a high-impedance voltmeter.

Low-Torque Potentiometers. H. D. Wright. *Machine Design*, Vol. 20, No. 5, May, 1948, pp. 134–136, illus., figs.

Typical applications of the Patin low-torque potentiometer. Resistances of from 100 to 25,000 ohms, a maximum brush current of 0.1 amp., a linearity of 0.2 per cent, and a theoretical angular resolution of $^1/_4°$ at 5,000 ohms make the instrument suitable for remote indication and control. Because the torque required is only 0.003 oz. per in., the potentiometer can be mounted directly on the dial of an indicating instrument.

Stall Warning Device (Arnold) Detects Airflow Loss Over Wing Surface. *Canadian Aviation*, Vol. 21, No. 6, June, 1948, p. 42, illus.

Temperature-Compensated Bubble Horizon. E. F. Flint. *Navigation*, Vol. 1, No. 10, June, 1948, pp. 216–220, figs. 4 references.

Summary of the manual methods and the semiautomatic methods that have been used to provide temperature compensation for the bubble horizon of a sextant. A fully automatic device is suggested which also permits the size of the bubble to be changed when the sextant is level in the observing position. The compensation chamber expands as the temperature rises and accommodates the overflow of the bubble-chamber liquid.

Magnetic Fluid Clutch. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 5, May, 1948, pp. 54–60, illus., figs. (Cf. AER 7/48:65.)

Psychological Problems in Cockpit Instrumentation for the Omni-Directional Range (ODR) and Distance Measuring Equipment (DME). Arthur W. Melton. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 76*, February, 1948. 29 pp., figs. 10 references.

A survey of the present status of omnidirectional range and distance-measuring equipment, basic cockpit instrumentation, the uses of this equipment, and R-Theta computers. The instruments that are suggested to improve the functioning of these systems include an omnibearing selector and ambiguity indicator, a course line deviation indicator, an omnibearing indicator, and a radio magnetic indicator. Instrumentation for the O.D.R.-D.M.E. course computers is also suggested. Eleven representative problems are listed to illustrate the psychological difficulties that arise with the adoption of this type of equipment.

A Novel Approach to Instrumentation. *Plane Facts*, Vol. 5, No. 4, April, 1948, pp. 7–9, 28, 29, fig.

Résumé of research by the Air Materiel Command on the intelligibility of the displays used in aircraft instruments, the types and quality of sensory data used by pilots during visual contact landings, and the improvement of both symbolic and pictoral instrument displays.

Laboratories, Aeronautical (50)

Research Dispersal (Commonwealth Advisory Aeronautical Research Council). *Aircraft*, Vol. 26, No. 8, May, 1948, pp. 18, 19, illus.

Synthetic Stratospherics; Development Equipment at Weybridge for High Altitude Research (Vickers-Armstrong). *Flight*, Vol. 53, No. 2059, June 10, 1948, pp. 641, 642, illus.

Trends in Aircraft Research. E. H. Heinemann. *Western Flying*, Vol. 28, No. 6, June, 1948, pp. 19, 20, figs. (An address.)

Machine Elements (14)

Sliding Friction of Ball Bearings of the Pivot Type. H. Poritsky, C. W. Hewlett, Jr., and R. E. Coleman, Jr. **Discussion.** W. D. Anderson. Thomas Barish. J. R. Macintyre and E. E. Lynch. Bryce Ruley. *Journal of Applied Mechanics*, Vol. 15, No. 2, June, 1948, pp. 181–185, illus., diagrs., figs. 5 references. (Cf. AER 4/48:57.)

The Imperfect Film Lubrication of Sliding Journals. L. Leloup. (*Revue Universelle des Mines*, Vol. 3 (9th Series), No. 10, 1947, pp. 373–419.) *The Engineers' Digest*, Vol. 5, No. 4, May-June, 1948, pp. 200–204, illus., figs. 8 references.

Measurements of Combined Frictional and Thermal Behavior in Journal-Bearing Lubrication. S. A. McKee, H. S. White, and

J. F. Swindells. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 409–418, illus., figs.

Data obtained in tests with a four-bearing friction machine show that the combined hydrodynamic and thermodynamic actions involved in journal-bearing operation with forced-feed lubrication produce an increase in frictional torque and fluidity of the lubricant proportional to an increase in the load on the bearing. The increase in torque is influenced by the viscosity of the oil, the oil-inlet temperature, the oil-feed pressure, the shaft diameter, the clearance-diameter ratio, and the length-diameter ratio. The increase in fluidity is influenced by the same factors and also by the speed of the journal. The empirical equations that are derived for the fluidity-pressure relationship provide a graphical method for estimating safe bearing loads.

Studies in Boundary Lubrication. II—Influence of Adsorbed Moisture Films on Coefficient of Static Friction Between Lubricated Surfaces. W. E. Campbell and E. A. Thruber. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 401–405, Discussion, 405–408, figs. 16 references.

Friction measurements on a highly refined paraffin-base oil applied to surfaces in equilibrium in a dry and a moist atmosphere and similar measurements with four fundamentally different types of lubricant on steel, brass, and glass in equilibrium with dry air and with air of 75 per cent humidity show that extraordinarily high values of the coefficient of static friction between steel surfaces lubricated with straight-chain normal hydrocarbons are caused by a film of adsorbed moisture at the solid-liquid interface. In all cases, and most noticeably with glass, high humidity increased the friction from 40 to 70 per cent. These results provide an explanation for many of the discrepancies among oiliness results in literature obtained by the static-friction method and indicate that the humidity of the atmosphere plays a significant part in the mechanism of boundary lubrication.

Preliminary Survey of the German Pump Industry. I—Centrifugal, Axial Flow, Self-Priming, and Reciprocating Pumps, Etc. G. A. Wauchope, G. W. Barton, and F. Harman. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1188, Item No. 31.* 88 pp., illus., figs., folding charts. British Information Services, New York. $3.00.

Survey of the German Pump Industry. II—Semi-Rotary Hand Pumps. G. B. Bass. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1188, Item No. 31.* 27 pp., figs. British Information Services, New York. $1.00.

Maintenance (25)

International Aircraft Maintenance. *Air World*, Vol. 1, No. 3, pp. 67–69, illus.

The plant, facilities, and services offered at the bases established by the Lockheed Aircraft Service, Inc., which specializes in heavy maintenance, servicing, repair, and modification of aircraft and offers a pooled service to individual operators.

Mid-Continent's Preventive Maintenance. *Airports and Air Carriers*, Vol. 13, No. 6, June, 1948, pp. 18, 19, 36, illus.

United Unveils "Push Button" Maintenance Repair Base (San Francisco). *Western Flying*, Vol. 28, No. 6, June, 1948, pp. 16, 17, illus.

Making Maintenance Pay Dividends. *Shell Aviation News*, No. 119, May, 1948, pp. 8–11, illus.

By decentralizing overhaul and repair bases, coordinating operating and maintenance schedules, and replacing a major air-frame component with a reconditioned unit at each 400-hour routine inspection, maintenance costs of Slick Airways, Inc., have been reduced by more than half.

Super-Overhaul Base for Big Planes. *Canadian Aviation*, Vol. 21, No. 6, June, 1948, pp. 46, 48, 70, illus. United Airlines overhaul base at San Francisco.

Fabric Care and Storage. William H. Weber. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, p. 34, illus.

Colonial's Oxygen "Filling Station." *Airports and Air Carriers*, Vol. 13, No. 6, June, 1948, p. 17, illus., diagr.

Douglas Service, Vol. 6, No. 6, June, 1948. 20 pp. diagrs. Contents: Automatic Pilot—Function of PB-10 Electronic System, DC-6. Plya-Seal Bearings—Recommended Washing and Relubricating Procedure, DC-6. Off-Neutral Control Surface Locks, DC-3. Heat and Vent System—Review of Recommended and Mandatory Changes Necessary for Latest Configuration, DC-4. Heater System Changes—Centerspread, DC-4. Horizontal Stabilizer Cover Plate—Removal Permits Easy Inspection, DC-4. Engine Shock Mounts—Disassembly, Inspection, Installation, and Storage, DC-6. Shock Mount Torque Values, DC-4.

Management & Finance (45)

How the Air Force Buys. II. III—Repricing Revisions. J. R. Martin. *Plane Facts*, Vol. 5, Nos. 4, 5, April, May, 1948, pp. 17, 30, 32; 16, 17, 32.

II. The advantages and disadvantages of formal advertising as a procurement method. Negotiated procurement is permitted under specified conditions. When no convenient yardstick of prices exists, a method is prescribed for analysis of the cost breakdown to be submitted with each bid.

Some Strings Attached to 1949 Military Aircraft Program. Robert McLarren. *Automotive Industries*, Vol. 98, No. 11, June 15, 1948, pp. 40, 41, 92, 96.

Materials (8)

A Variational Principle for Plastic Materials With Strain-Hardening. P. Hodge and W. Prager. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 1–10. 7 references.

By an analysis of the relations of the stresses and the strains in a plastic material with strain hardening under loading or unloading, the volume integral of the invariant $\sigma_{ij}\dot{\epsilon}_{ij}$ (product of the stress and the strain), over the entire body is shown to be less for the actual stress rates than for any system of artificial stress rates that satisfy equilibrium conditions and which either are indefinitely near the actual stress rates or constitute unloading in all regions of the body where the actual stress rates constitute unloading.

METALS & ALLOYS

Strain Energy in Greatly Deformed Elastic or Inelastic Anisotropic Engineering Metals. K. H. Swainger. *Franklin Institute, Journal*, Vol. 245, No. 6, June, 1948, pp. 501–516, figs. 20 references.

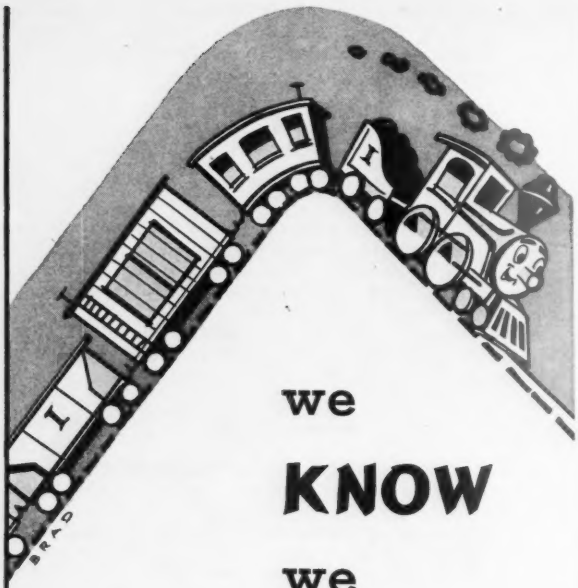
The equilibrating stresses on an orthogonal element in a strained body induce normal strains defined as relative displacement per unit length of deformed body. This vector "straining"-displacement must be a point function for continuity of the solid. The work done by the forces on the faces of an orthogonal element of unit volume in the loaded body during a differential increase of deformation is found. Integration gives the total work done on the element from the initial unstrained state up to the current state of deformation.

A Theory of the Yielding and Plastic Flow of Anisotropic Metals. R. Hill. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 281–297, figs. 12 references.

A theory that offers a macroscopic description of the yielding and plastic flow of metals that display anisotropy due to preferred orientation. The general yield criterion is similar in form to the Huber-von Mises criterion for isotropic metals but contains six parameters specifying the state of anisotropy. The von Mises concept of a plastic potential is used to obtain the associated relations between the stress- and strain-increment tensors. The theory agrees with the experimental data of Korber and Hoff on the necking under uniaxial tension of thin strips cut from rolled sheets. There are generally two equally possible necking directions whose orientation depends on the angle between the strip axis and the rolling direction. The theory can be used to determine the earing positions in cups deep-drawn from rolled sheet, and it predicts the changes in length observed by Swift in a thin-walled cylinder under pure torsion sufficient to produce anisotropy.

Biaxial Plastic Stress-Strain Relations for 24S-T Aluminum Alloy. Joseph Marin, J. H. Faupel, V. L. Dutton, and M. W. Brossman. *U.S., N.A.C.A., Technical Note No. 1536*, May, 1948. 96 pp., illus., figs. 16 references.

Contains determination of the yield strength, ultimate strength, ductility, and plastic stress-strain relations for 24S-T aluminum alloy when subjected to biaxial stresses. Both biaxial stresses considered were tensile, and the influence of various biaxial stress ratios on the mechanical properties was determined. The data were interpreted by a generalized St. Venant theory in an at-



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tempt to predict the biaxial stress-strain relations. The stress-strain relations, as predicted for combined stresses by this theory, agree approximately with the test results.

Modern Light-Alloy Engineering. *The Aeroplane*, Vol. 124, No. 1928, May 21, 1948, pp. 612–614, illus.

Description of the equipment, facilities, and production of High Duty Alloys, Ltd., at their plants at Slough and Redditch. The properties of various aluminum alloys in the RR, the Hiduminium, and the Magnuminium alloys are briefly noted.

Engineering Characteristics of 61S Aluminum Alloy Sheet. Joseph J. Warga. *Product Engineering*, Vol. 19, No. 6, June, 1948, pp. 108–112, illus., figs.

Exhaust Valve Coatings Resistant to Lead-Compound Attack. R. Graham and P. G. Pigneguy. *Shell Aviation News*, No. 119, May, 1948, pp. 14–21, illus., figs.

Because the original experiments at the Thornton Aero-Engine Laboratory in the application of a nickel-aluminum alloy coating to exhaust-valve heads yielded erratic results in engine tests, a nickel-cobalt-aluminum ternary alloy coating was developed. Engine tests of exhaust valves so coated, analyses of deposits, and metallurgical investigation showed that the ternary alloy decreased the corrosion resulting from the use of leaded fuels by the formation of a stable and refractory oxide coating on the alloy. The coating is best produced by the immersion of the valve in the molten alloy, to ensure its reaction with the valve material followed bya diffusing treatment to produce homogeneity in the bonding of the valve material and the coating alloy.

Influence of Low Temperatures on the Mechanical Properties of 18:8 Chromium-Nickel Steel. D. J. McAdam, Jr., G. W. Geil, and Frances Jane Cromwell. *U.S., National Bureau of Standards, Journal of Research*, Vol. 40, No. 5, May, 1948, pp. 375–392, figs. 19 references. Available also as *Research Paper No. RP1882*. U.S. Govt. Printing Office, Washington. $0.15.

By means of tension tests of notched and unnotched specimens an investigation was made of the mechanical properties of various 18:8 chromium-nickel steels between room temperature and −188°C. One of the steels was ferritic; the others were of the metastable austenitic type. Plastic deformation of the metastable austenitic alloys causes a phase change and thus hardens the alloy. The rapidity of this change increases with decrease in temperature. At low temperatures the hardening due to the phase change is so rapid that the load-extension curve sometimes has two maxima. For this reason six important strength indices sometimes are required to evaluate the mechanical properties.

Tungsten Resources of Japan. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./-1718*, April 29, 1947. 29 pp., figs. 15 references. British Information Services, New York. $1.00.

Molybdenum in Japan. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./J.A.P./P.R./1665*, March 14, 1947. 26 pp., figs. British Information Services, New York. $0.90.

Age Hardening of Metals. Kotaro Honda. *Gt. Brit., British Intelligence Objectives Sub-Committee, Report No. B.I.O.S./-J.A.P./P.R./1593*. 4 pp. British Information Services, New York. $0.35.

The changes in hardness during the special heat-treatment that produces rebuilding of aluminum-copper alloys is cited to show the simultaneous operation of strain and crystallization age-hardening of an alloy.

Stabilization of Austenitic Stainless Steel. Samuel J. Rosenberg and John H. Darr. *U.S., National Bureau of Standards, Journal of Research*, Vol. 40, No. 4, April, 1948, pp. 321–338, figs. 8 references. Available also as Research Paper RP1878. U.S. Govt. Printing Office, Washington. $0.15.

A study was made of the resistance to intergranular attack of 23 18 per cent Cr, 10 per cent Ni austenitic corrosion-resisting steels in twelve different initial conditions. Susceptibility to intergranular attack was determined after seven sensitizing treatments, followed by exposure for a maximum of 14 days in a boiling acidified copper sulphate solution. It was found that maximum susceptibility to intergranular attack was developed by sensitizing either 8 or 21 days at 1,020°F. The straight carbon austenitic steels were vulnerable to attack, although decrease in carbon content decreased the degree of vulnerability. The columbium- and titanium-treated steels were satisfactorily resistant to attack provided the Cb/C or Ti/C ratios were sufficiently high. These ratios varied, depending on the initial condition of the

steel. The carbon content of the treated steels had no influence upon the resistance to intergranular attack, the predominating factor being the Cb/C or Ti/C ratio.

An Investigation of Fretting Corrosion Under Several Conditions of Oxidation. B. W. Sakmann and B. G. Rightmire. *U.S., N.A.C.A., Technical Note No. 1402*, June, 1948. 57 pp., illus., diagrs., figs. 11 references.

Tests on the fundamental mechanism of fretting corrosion of various materials, including steel, phosphor-bronze, tin, aluminum, aluminum alloy, lead, lead-plated steel, and chromium steel, in air, in vacuum, in oxygen, and in helium under identical conditions of load and slip. Chemical action is of primary importance, and hard oxide formation does not give protection to the metals but rather increases the rate of wear. In most cases of fretting, wear is of such a severe nature that protective oxide films are abraded.

Calibration of X-Ray Measurement of Strain. John A. Bennett and Herbert C. Vacher. *U.S., National Bureau of Standards, Journal of Research*, Vol. 40, No. 4, April, 1948, pp. 285–293, figs. 4 references. Available also as Research Paper RP-1874. U.S. Govt. Printing Office, Washington. $0.15.

In order to increase the precision of strain determination by x-ray methods, twelve measurements of ring radius were made on each of two patterns for the customary incidence angles of 90° and 45°. For a specimen to which uniaxial stress was applied, a method was developed for handling the data to give one value representative of these 24 readings. When these values (obtained on a flat steel specimen loaded in bending) were compared with mechanical strain measurements, it was found that the x-ray measurements were proportional to the maximum principal strain up to the beginning of plastic deformation, and the precision was such that a change corresponding to 1,000 lbs. per sq.in. should be detectable.

New Creep Testing Machines. Joseph Marin. *Automotive Industries*, Vol. 98, No. 9, May 15, 1948, pp. 46, 78, figs.

Design and Applications of a New Metals Comparator. D. E. Bovey. *Instruments*, Vol. 21, No. 5, May, 1948, pp. 467–470, illus., figs.

An instrument enabling the nondestructive rapid testing of a metal to determine whether or not it is identical with a standard specimen in composition and characteristics. The test specimen is inserted in a solenoid through which passes an alternating current. The effect of the magnetic properties of the material on the inductance of the coil either balances or unbalances the instrument, thus showing whether the sample has electrical and magnetic properties identical with the standard sample for which the comparator was originally adjusted. The wide range of frequencies that may be used in the solenoid make it possible to examine either the core or the surfaces of specimens.

Indium Plated Lead Bearings Withstand High Stresses. Joseph Albin. *Materials & Methods*, Vol. 27, No. 6, June, 1948, pp. 88, 89, illus.

Thickness Standards for Cadmium Electroplate. George Black. *Product Engineering*, Vol. 19, No. 6, June, 1948, p. 165. Four specifications for commercial deposition: A.S.T.M. A165-40T, AN-P-61-2, AMS 2400E, and Navy Dept. 46-P-1.

Thickness Standards for Zinc Electroplate. George Black. *Product Engineering*, Vol. 19, No. 6, June, 1948, p. 167. Four specifications for commercial deposition: A.S.T.M. A164-40T, AN-P-32a, AMS 2402B, and Navy Dept. 46-P-2.

Investigation of the German BDS Chromizing Process (Project No. FQ-191). C. A. Naugle. *U.S., Air Force, Technical Report No. F-TR-1183-ND*, May, 1948, 33 pp., figs. 6 references.

The Becker, Daeves, and Steinberg chromizing process of the Metall und Diffusionsgesellschaft A.G. uses chromous chloride at a temperature of 1,832°F. to produce, on the surface of low-carbon steels, a temperature- and corrosion-resistant zone in which chromium atoms have replaced the iron atoms. The basic process, or slight modifications of it, were in use in six licensee plants. Attempts to produce this surface treatment by a salt-bath method were abandoned because of the corrosive action of the liquid salts. Because of the sensitivity of chromium diffusion to carbon migration and the consequent lowered corrosion resistance, a special high-titanium content steel, the IK series (Inkromstahl), was developed. This series of steels had superior strength, corrosion- and temperature-resistance, and creep characteristics.

Experiences With the Rochelle Copper Plating Solution (for the Plating of Aircraft Engine Components). N. A. Tope. *Sheet Metal Industries*, Vol. 25, No. 254, June, 1948, pp. 1191–1194. 2 references.

Friction and Wear of Metals in the Presence of Liquid Gases. P. I. Riumin and I. U. N. Riabinin. (*Kislorod* (U.S.S.R.), No. 4, 1946, pp. 35–41.) *The Engineers' Digest*, Vol. 5, No. 4, May-June, 1948, p. 186.

NONMETALLIC MATERIALS

Laminated "Plexiglas" in Aircraft. I. W. F. Bartoe and E. N. Robertson. *Aero Digest*, Vol. 56, No. 5, May, 1948, pp. 42–45, 102, 104–106, figs.

A discussion of the physical characteristics of laminated Plexiglas and its components, methacrylate and polyvinyl butyral, and the effect of fabrication and handling techniques on its optical properties. The location of the heat-distortion temperatures of the two materials indicates that the sandwich should display a transition in its physical properties between 0° and −20°C. At 0°C. the impact strength of the laminate begins to increase until at 10°C. it is twice that of the solid methacrylate. As the temperature increases to 40°C., the strength of the laminate decreases to a value equal that of the solid. In notch effect tests, the unnotched laminate had a lower strength than the solid at temperatures below 0°C. Notched specimens, however, were equal in strength to the solid down to −60°C. The quality and the nature of the bonding between the layers of the sandwich exercise a decisive effect on its strength. When no adhesive was used, a higher impact strength was displayed at temperatures below 0°C. than that observed for either the adhesive-bonded laminate or the solid methacrylate. Variations in the quality of the bond, the quality of the finish of the interfaces, and the thickness of the laminate are the principal sources of optical distortion, haze, and variations in light transmissivity.

Ceramics May Serve in Turbines and Jets; For Turbine Blades. R. F. Geller. *SAE Journal*, Vol. 56, No. 6, June, 1948, pp. 46, 48. (Summary of a paper: Ceramic Bodies for Turbojet Blades.)

Characteristics and Configurations of Reinforced Plastic Joints. II. Richard J. Francis. *Product Engineering*, Vol. 19, No. 6, June, 1948, pp. 134, 135, diagrs. Ribbing structural plastic parts, 90° joints in sandwich, typical edge treatments for sandwich, bolted and riveted joints, and hinge joints.

The Effect of Fungi and Humidity on Plastics. John Leutritz, Jr. *American Society for Testing Materials, Bulletin*, No. 152, May, 1948, pp. 88–90, illus., fig.

A Constant Stress Apparatus for the Study of the Creep Properties of Plastics. A. G. Ward and R. R. Marriott. *Journal of Scientific Instruments*, Vol. 25, No. 5, May, 1948, pp. 147–151, illus., figs. 9 references.

SANDWICH MATERIALS

An Investigation of Mechanical Properties of Honeycomb Structures Made of Resin-Impregnated Paper. C. B. Norris and G. E. Mackin. *U.S., N.A.C.A., Technical Note No. 1529*, May, 1948. 39 pp., illus., figs. 3 references.

The modulus of rigidity, shear stress at proportional limit, and shear strength of resin-impregnated paper honeycomb structures compare favorably with those of balsa wood. The modulus of elasticity, compressive stress at proportional limit, compressive strength, and tensile strength of resin-impregnated paper honeycomb structures are lower than those of balsa wood but are considerably higher than those of cellular cellulose acetate and cellular hard rubber.

Meteorology (30)

A Report on Thunderstorm Conditions Affecting Flight Operations. (*Thunderstorm Project, Published Contribution No. 4.*) *U.S., Weather Bureau, Technical Paper No. 7*, April, 1948. 52 pp., figs. 15 references.

A partial analysis of meteorological data obtained from 185 thunderstorms in Florida and Ohio by the Thunderstorm Project. Flight, ground, and radar observations were made to establish the vertical extent of the storm, its structure, and the intensity, frequency, and distribution of gusts and drafts. The levels near and slightly above the freezing level seem to contain the maximum occurrences of heavy icing, hail, turbulence, and lightning strikes. The displacement of the aircraft from its entry altitude caused by drafts is not considered to be serious, but a positive source of danger does exist in any attempt to hold an assigned altitude. The nose-high or nose-low attitude that this requires, coupled with

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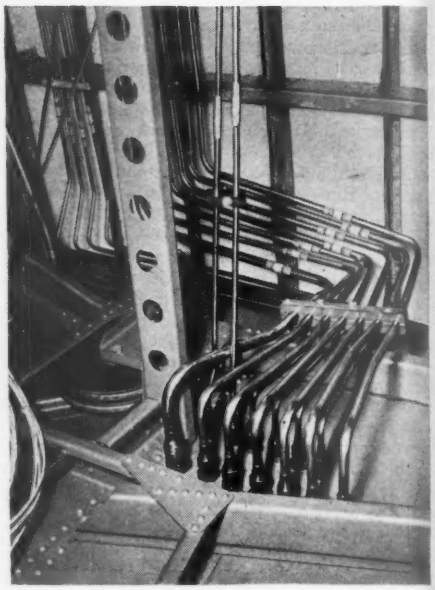

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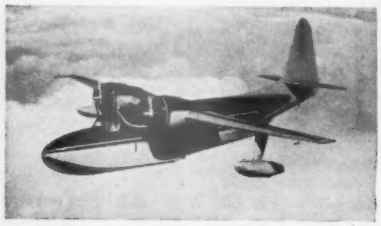

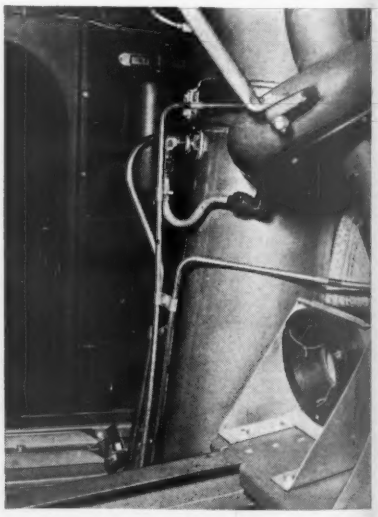

(Left) Grumman JR2F *Albatross.* Air-sea rescue amphibian built by Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y. *(Center)* Grumman *Mallard.* This is the first amphibian to pass the latest, most stringent Civil Aeronautics Administration's tests to qualify for a "Scheduled Air Carrier Operations" rating. *(Right)* MONEL tubing used for fuel pressure lines in the Grumman *Mallard.*

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the resulting air-speed changes, can be the initiating circumstance for a spiral dive or an inadvertent stall. Under conditions of precipitation the greatest error in the altimeter indication and maximum turbulence were observed. First gusts velocities, the duration of the caution period, and the origin of the wind shift are considered in relation to take-off and landing.

The Thunderstorm Project (U.S. Weather Bureau): Operation Report on Phase II. Fred D. White. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 192–194, map. 3 references.

Joint Meeting of Airlines Meteorologists and Thunderstorm Project Personnel, Chicago, June 1, 1948. *U.S., Weather Bureau, Thunderstorm Project*, June, 1948. 16 pp., illus., fig. Summary of the discussions.

Electric Field Intensity Inside of Natural Clouds. Ross Gunn. *Journal of Applied Physics*, Vol. 19, No. 5, May, 1948, pp. 481–484, figs. 6 references.

Measurements were made of the electric field on the surface of an airplane flying through all types of weather and clouds. The measured electric field inside a thunderstorm just prior to a lightning strike at 12,900 ft. was 3,400 volts per cm. The average maximum field for nine different thunderclouds was 1,300 volts per cm. It is noted that large fields usually occur only inside the cloud and at altitudes somewhat comparable to the freezing level. Frequent reversals of the field are observed in these areas. The electric field measured inside a stable nonprecipitating cloud is less than 10 volts per cm.

Analysis and Preliminary Design of an Optical Instrument for the Measurement of Drop Size and Free-Water Content of Clouds. Willem V. R. Malkus, Richard H. Bishop, and Robert O. Briggs. *U.S., N.A.C.A., Technical Note No. 1622*, June, 1948. 60 pp., illus., diagrs., figs. 6 references. The design and operation of an optical instrument in which the intensity of an artificially created rainbow is used to determine the drop size and the free water in clouds.

An Analysis of the Variation With Altitude of Effective Gust Velocity in Convective-Type Clouds. H. B. Tolefson. *U.S., N.A.C.A., Technical Note No. 1628*, June, 1948. 15 pp., figs. 7 references.

Gust-velocity data for altitudes up to 34,000 ft. are analyzed. No appreciable variations with altitude occur in the gust experience per mile flown within convective-type clouds up to 34,000 ft. The results obtained from the tests could be extrapolated to altitudes above 34,000 ft. for convective-type clouds that are within the troposphere.

Effect of Support on the Performance of Vane Anemometers. Galen B. Schubauer and Gerald H. Adams. *U.S., National Bureau of Standards, Journal of Research*, Vol. 40, No. 4, April, 1948, pp. 275–280, illus., figs. Available also as *Research Paper RP1872*. U.S. Govt. Printing Office, Washington. $0.10.

Three-, 4-, and 6-in. vane anemometers were tested in a wind tunnel to determine the effect of the aerodynamic interference caused by supports of various types. Average changes in indicated speed as high as 15 per cent of the true speed were observed. A rod support with a clamping device downstream from the instrument was adopted as a standard mounting because even when the rod was as short as 4 in., the interference effect was only in the order of 1 or 2 per cent.

A New Gradient-Wind Nomogram. W. L. Godson. *American Meteorological Society, Bulletin*, Vol. 29, No. 3, March, 1948, pp. 95–100, figs., fold. chart. 3 references.

A nomographic solution for the gradient-wind equation in terms of the curvature of pressure-contour lines and the motion of pressure-contour systems. The gradient wind can be found as a function of the geostrophic wind and the radius of curvature of the trajectory evaluated.

Development of Dust Whirls and Similar Small-Scale Vortices. Nelson R. Williams. *American Meteorological Society, Bulletin*, Vol. 29, No. 3, March, 1948, pp. 106–117, figs. 13 references.

Cirrus "Stripes" and Typhoons. Charles E. Deppermann. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 166–174, illus., fig.

Meetings of the International Meteorological Organization (I.M.O.) in Toronto and Washington, 1947. I. R. Tannehill. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 146–154.

The Variation of the Time of Maximum Precipitation Along the West Coast of North America. Philip Williams, Jr. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 143–145, fig. 2 references.

On Kibel's Method of Forecasting in Relation to Exner's Theory. Heinz Lettau. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 201, 202. 6 references.

A Study of "Waves" in the Easterlies. Prepared by AAF Weather Research Station, Ninth Weather Squadron. Reviewed by H. Riehl. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 196–198.

A One-Year Cumulative Frequency-Distribution of the Height Gradient of the 850-mb Constant-Pressure Surface Over North Central U. S. U.S., Air Weather Service. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, p. 202, fig.

Pulse Reflections From the Tropopause and Ozone Layers (10 to 30 km). E. Gherzi. *American Meteorological Society, Bulletin*, Vol. 29, No. 3, March, 1948, pp. 136–139, figs.

The Effect of Continentality in the Middle Troposphere Over North America. Frank Gifford, Jr. *American Meteorological Society, Bulletin*, Vol. 29, No. 4, April, 1948, pp. 194, 195, maps.

Meteorological Conditions Accompanying Mirages in the Salt Lake Desert. Ronald L. Ives. *Franklin Institute, Journal*, Vol. 245, No. 6, June, 1948, pp. 457–473, illus., figs. 11 references.

Navigation (29)

A New Method of Navigation. Robert W. Mudge. *Air Facts*, Vol. 11, No. 6, June 1, 1948, pp. 11–19, fig.

A rapid and simple method of determining the amount of drift correction to be expected during short-haul low-level operations. A constant that varies for the latitude is applied to the difference in altimeter setting between the initial and terminal airports. The drift thus calculated is reasonably accurate at altitudes less than 5,000 ft.

Operations

COMMERCIAL (41)

High Speed High Altitude Flying—in Airline Operation. C. H. Jackson. *Speedbird*, Summer, 1948, pp. 2–7, illus.

The lower costs, increased schedule regularity, and the greater demand for air transport which are predicted for high-speed, high-altitude aircraft powered by jet or turbine engines await the solution of a number of basic problems. Twelve that are common to the aircraft designer and the operator are tabulated, with a brief comment on the effect of each on aircraft design and on the operators' programs, the status of current development or research, and its adequacy. Problems include: economical production of engines, high fuel consumption of turbine engines at low altitudes and powers, prevention of turbine icing, meteorological data at high altitudes, local speed-of-sound barrier, low-speed control and stability, suppression of radio antennas in aircraft structures, noise, the effect of pressure loss caused by failure of cabin window, and miscellaneous physiological problems.

Air Transportation Development. John H. Frederick. *Distribution Age*, Vol. 47, No. 5, May, 1948, pp. 38, 51, 66, 67, 79, 80, illus.

An effective air safety program should include an integrated system of navigation and landing aids and aircraft designed to minimize the possibility of pilot error. Air regulations should apply to all carriers and should give the pilot sufficient latitude in making decisions so that he may discharge his responsibility for the safety of his craft and passengers.

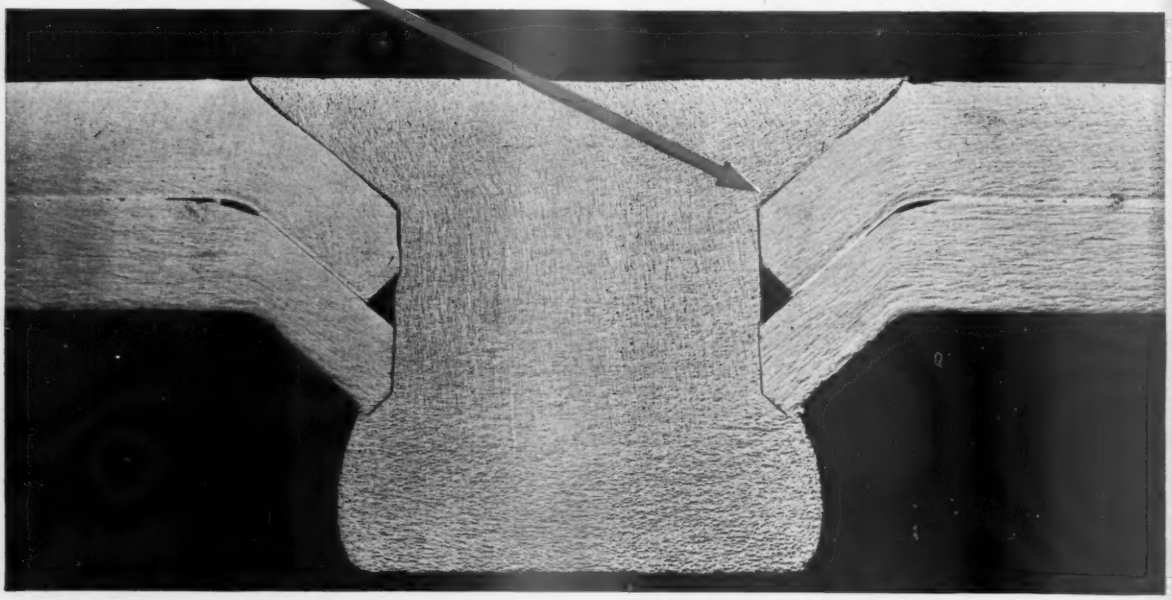
Delays are Dynamite. *Between Ourselves (Trans-Canada Air Lines)*, No. 61, May, 1948, pp. 4–6.

Three-fifths of the irregularities in air-transport service that arise from cargo and passenger handling can be charged solely to the air-line operator. Trans-Canada Air Lines is attempting to reduce these delays by reducing paper work at the airport counter, planning and expansion of its facilities, and revision of its schedules. The Station Services Department coordinates these programs and makes analyses to determine the cause of schedule irregularities.

Size in Transport; A Review of Development, With Particular Respect to Size and its Lessons to Air Transport. A. Gouge. *Flight*, Vol. 53, No. 2058, June 3, 1948, 614–616, figs. (Extended summary of a paper.)

Air Transport Problems. E. S. Land. *Preprint, S.A.E. Summer Meeting, French Lick, Ind.*, June 6–11, 1948. 6 pp.

Alcoa research points the way to BETTER DIMPLING of Alclad 75S-T6 sheet



Photomicrograph of successful flush-riveted joint between Alclad 75S-T6 sheets.

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Civil Air Transport. H. W. C. Alger. *Institute of Transport, Journal*, Vol. 22, No. 18, April-May, 1948, pp. 657, 658, 651. (Extended summary of an address.)

United States Air Freight and Irregular Air Carriers. *Air Transportation*, Vol. 12, No. 4, April, 1948, pp. 23–38. An alphabetical list of about 1,500 firms engaged in nonscheduled and fixed-base operations. Includes tables of foreign air-mail and air parcel-post rates.

The Strange Case of Airline Economics. Harold D. Koontz. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, pp. 13, 37.

In view of the pay loads with which other transportation agencies have had to operate, the air-transport industry should aim for a break-even passenger load factor of 50 per cent and a break-even pay-load factor of 45 per cent. Because substantial reductions have already been made in indirect costs, further savings will probably be in direct costs. The sharing of the results of technical research and the standardization of aircraft could increase the efficiency of both maintenance and operation.

Air Lines of the World. *The Aeroplane*, Vol. 74, No. 1927, May 14, 1948, pp. 561–568, 575–582, illus. A compilation of information on the organization, routes, aircraft, and personnel of 183 air lines.

World's Air Line Figures. *The Aeroplane*, Vol. 74, No. 1927, May 14, 1948, pp. 569, 570, 573, 574.

A tabulation of statistics for 1946 on the number and type of aircraft used by each company, total personnel, number of aircraft captains, total route mileage, miles flown, number of passengers carried, passenger-miles, tons or ton-miles of mail, and tons or ton-miles of freight. The 93 air lines are listed by continent and country.

Operating Figures of British Airlines. *Modern Transport*, Vol. 109, No. 1520, May 18, 1948, p. 9, illus.

Indian Air Transport Climbing. J. K. Van Denburg, Jr. *Aviation Week*, Vol. 48, No. 20, May 17, 1948, p. 31, illus.

Sabena; The Story of Belgian Airlines. *Air World*, Vol. 1, No. 3, pp. 50–53, illus.

Increase in T.C.A. Traffic; Higher Costs Offset Greater Revenue; Plans for Development in 1948. *Modern Transport*, Vol. 109, No. 1519, May 8, 1948, p. 9.

T.C.A. Schedules with North Stars. *Modern Transport*, Vol. 59, No. 1523, June 5, 1948, p. 12, illus.

Across Arctic Canada; Work of Aircraft and Tractor Trains. *Modern Transport*, Vol. 59, No. 1523, June 5, 1948, pp. 13, 14, illus.

The Development of Air Services in Southern Africa. *Shell Aviation News*, No. 120, June, 1948, pp. 10, 11, illus.

Air Freighting Economics; A Study of Facts and Figures. H. W. Ainsley. *Airports & Air Transportation*, Vol. 2 (N.S.), No. 60, May, 1948, pp. 411–413. With a brief analysis of statistics of British and American air freight, 1928–1947.

Air Cargo "Picks up its Feet." Jerome M. Miller. *Distribution Age*, Vol. 47, No. 5, May, 1948, pp. 35, 53, 78, 79, illus. The organization used by 20th Century Delivery Service, Inc., to adapt its surface freight-forwarding service to handle air cargo.

Never the Twain Shall Meet. Robert W. Prescott. *Air Transportation*, Vol. 12, No. 4, April, 1948, pp. 8–10, 41–46, illus.

A discussion of the history of the air transportation of cargo both by the scheduled passenger carriers and the unscheduled cargo air lines. The cargo lines claim that the best interests of the public would be served by unrestricted competition with the passenger carriers and by conducting cargo operations in conjunction with established surface-freight forwarders.

Stowing Air Cargo. Robert A. Terry and Harold A. Storch. *Air Transportation*, Vol. 12, No. 4, April, 1948, pp. 39, 40.

A review of current methods of securing air-borne cargo. The use of ropes, tie-down equipment, webbed straps, bins, cargo nets, compression packing, preloaded containers, and paletizing all have inherent disadvantages. The ideal solution will probably be found in the detachable cargo hold designed specifically for the type of goods to be carried.

Spotlighting the United States Canada Air Cargo Potential. P. L. Breakiron and R. W. Hoecker. *Air Transportation*, Vol. 12, No. 4, April, 1948, pp. 16–19, 51–53, illus. An analysis of the air-cargo import and export potential of the St. Lawrence and Maritime areas of Canada.

Spotlighting the United States-Canada Air Cargo Potential. II. P. L. Breakiron and R. W. Hoecker. *Air Transportation*, Vol. 12, No. 5, May, 1948, pp. 14–16, 44–46, illus., table.

Report on the Air Freight Forwarder Case. J. Earl Cox. *Air Transportation*, Vol. 12, No. 5, May, 1948, pp. 8, 9, 34–43.

First Class Passengers All. C. M. Bounevialle. *Shell Aviation News*, No. 120, June, 1948, pp. 8, 9, illus. An account of the transporting of livestock from England to East Africa by air.

North Atlantic Flight Refuelling; Tests on B.O.A.C. Freight Service. *Modern Transport*, Vol. 59, No. 1523, June 5, 1948, p. 11, illus.

MILITARY (24)

One-Way Mission. F. X. Purcell, Jr. *Skyways*, Vol. 7, No. 6, June, 1948, pp. 17–19, 44, 56, illus.

An analysis of the strategic and tactical aspects of the use of suicide bombing missions to gain initial advantage in a war. A program that would give greater assurance of success would be the establishment of fully equipped task forces with specialized combat and technical personnel to establish and construct advance air bases and the adoption of a landing gear that would permit bombers to land on hastily constructed air strips.

Jet Fighter Base. Nathaniel F. Silsbee. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 54, 55, illus. The 14th Fighter Group at Dow Air Force Base, Bangor, Me.

Personal Flying (42)

The Airplane and You. Wolfgang Langewiesche and Leighton Collins. *Air Facts*, Vol. 11, No. 6, June 1, 1948, pp. 54–81. The advantages, operating costs, and relative safety of private flying, and the probable duration of a pilot-training course.

Better Travel by Private Plane. II. Neil B. Berboth. *Southern Flight*, Vol. 29, No. 6, June, 1948, p. 14.

The advantages to business men and private users of leasing and renting aircraft.

Personnel (37)

How Pan American Trains Clipper Crews. *Airports and Air Carriers*, Vol. 13, No. 5, May, 1948, pp. 10, 38, illus.

A flight trainer developed by Curtiss-Wright Corporation provides exact simulation of all the instrument indications that might be obtained during actual flight in the Boeing 377 Stratocruiser. The reproduction of the cockpit has flight stations for each of the operating personnel so that they may be trained simultaneously. The instructor's unit contains devices to record the simulated altitude and flight path. The instructor can produce indications of emergency conditions.

C-W Unveils Flight Simulator. Stanley L. Colbert. *Aviation Week*, Vol. 48, No. 21, May 24, 1948, p. 16, illus. The Curtiss-Wright electronic crew trainer for the Boeing 377 Stratocruiser.

Photography (26)

Essentials of Microphotography. Kurt Michel. (*Carl Zeiss, Jena*), 1943. *U.S., Air Force, Translation No. F-TS-5544-E (ATI-20735)*, May, 1948. 120 pp., illus., diagrs., figs. 11 references.

A comprehensive presentation of the theory and technique of microphotography. An explanation of the basic geometric optics and laws of wave optics involved in the optical systems of simple and compound microscopes and of condensers shows the factors determining the relation between the scale of projection and magnification, the obtainable depth definition, and characteristics of the various methods of illumination. The section on the instruments used in microphotography includes light sources, light-field and dark-field illuminating systems for the simple and compound microscope, light filters, the microscope stand, the microphotographic objective, and the various types of microscope objectives and eyepieces. Illustrations, as well as descriptions, are given of commercial examples of the vertical, horizontal, and motion-picture and attachment cameras. Nomograms and tables supplement a detailed outline of the factors to be considered in selecting and preparing the subject, choosing the lenses and type of projection, adjusting the various types of illuminating systems, focusing the image on the plate, and selection and processing of the photographic materials. Discussions of microphotographs in natural color, infrared, ultraviolet, and polarized light, and stereomicrophotographs are included.

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Thornton Research Centre Laboratories. *The Engineer*, Vol. 185, No. 4818, May 28, 1948, pp. 526–528, illus.

Outline of the growth of the laboratory of Shell Refining and Marketing Company, Ltd., and description of its main facilities and projects.

Effect of Hydrocarbon Type and Chain Length on Uniform Flame Movement in Quiescent Fuel-Air Mixtures. Thaine W. Reynolds and Earl R. Ebersole. *U.S., N.A.C.A., Technical Note No. 1609*, June, 1948. 14 pp., figs. 6 references.

An investigation of the effect of unsaturation and of chain length of straight-chain hydrocarbons on the uniform flame velocity in quiescent fuel-air mixtures has been carried out using 20 fuels. The peak flame velocity increased with increased unsaturation in a molecule of given size. For the unsaturated compounds, the peak flame velocity decreased as the chain length was increased. The peak flame velocity of the saturated straight-chain compounds was essentially the same.

The Art of the Aviation Engine. F. R. Banks. *The Aeroplane*, Vol. 74, No. 1927, May 14, 1948, pp. 584–587, illus. (Extended summary of a paper.) (Cf. AER 8/48:67.)

The Art of the Aviation Engine. F. R. Banks. *Flight*, Vol. 53, No. 2055, May 13, 1948, pp. 530, 531, 534, illus. (Summary of an address.) (Cf. AER 8/48:67.)

Symbols for Combustion Research. N.A.C.A. Subcommittee on Combustion. *U.S., N.A.C.A., Technical Note 1507*, June, 1948. 5 pp.

JET & TURBINE (5)

Equilibrium Running of the Simple Jet-Turbine Engine. A. W. Morley. *Royal Aeronautical Society, Journal*, Vol. 52, No. 449, March, 1948, pp. 305–322, figs.

A set of nondimensional parameters are derived which connect the principal quantities that govern the flow of gas through the intake, compressor, combustion chamber, turbine, and final propulsion nozzle of the turbojet system. Plots of these parameters show the points at which the characteristics of the various components are in equilibrium. By these plots the behavior of the engine at points away from the design point may be predicted. Investigation of the effect of changes in component characteristics become problems in the geometry of these curves. The plots also show the link between the behavior of the jet engine and aircraft parameters.

Temperature Measurements and Combustion Efficiency in Combustors for Gas-Turbine Engines. Walter T. Olson and Everett Bernardo. *American Society of Mechanical Engineers, Transactions*, Vol. No. 4, May, 1948, pp. 329–333, Discussion, pp. 333, 334, figs. 8 references.

Numerous investigations of the general altitude performance of combustors for gas-turbine engines indicated that air temperatures at the inlet to the combustors can be adequately measured with common bare-wire thermocouples and that at the combustor outlet large variations in temperature distributions, nonuniform velocity distribution, and fluctuations in the temperatures are among the possible sources of errors in measuring the average combustor-outlet temperatures. The temperatures measured at the combustor outlet, however, although not accurate, are generally satisfactory for evaluating the altitude performance of combustors. The values of combustion efficiencies obtained from temperature measurements are satisfactory approximations of combustion efficiencies which serve to show the effect of primary variables on combustion efficiency. Discussion of the thermocouple installations used, some of the construction details of typical thermocouples, and representative temperature and combustion-efficiency measurements are included.

Gas-Turbine Plant Combustion-Chamber Efficiency. A. L. London. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 317–323, Discussion, pp. 323–328, figs. 5 references.

Three distinct efficiency terms for combustion-chamber efficiency are proposed as standards that are relatively easy to apply both in evaluation of test performance and in cycle analysis of gas-turbine power plants. One term encompasses incomplete combustion and setting losses or heat leaks in the chamber. The second includes the flow friction and auxiliary-drive requirements. The third term expresses the influence of these losses on overall plant thermal efficiency and output. The formulas are defined and examples are given of their employment.

Determination of Gas-Turbine Combustion-Chamber of Efficiency by Chemical Means. Peter Lloyd. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 335–341, Discussion, p. 341, figs.

In addition to being more accurate than the heat-balance method, the chemical method, using the gravimetric technique, of determining the efficiency of a gas-turbine combustion chamber can be used in engine tests. It also indicates the nature of the combustion loss. Various approximate methods—chemical, physicochemical, and physical—can be devised and calibrated against an exact and complete chemical determination. Description of sampling technique, the Cambridge Vacuum Fractionation method, the N.G.T.E. Gravimetric method, and tabulation of specimen are included.

Axial-Flow Compressors for Gas Turbines. A. I. Ponomareff. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 295–306, illus., figs.

A summary of the basic principles and operating characteristics of the axial-flow compressor. The flow pattern imparted by the configuration of the stationary and the rotating blades distinguish the various types of compressor, symmetric or constant reaction, nonsymmetric axial inlet stage, and vortex inlet flow stage. The effects of velocity ratio, hub-tip diameter and aspect ratios, reheat, Mach Number, and Reynolds Number are discussed.

Calculated Performance of 12-Cylinder Liquid-Cooled Engine With Exhaust-Gas Turbine Geared to Crankshaft. Leland G. Desmon and Ronald B. Doyle. *U.S., N.A.C.A., Technical Note No. 1602*, June, 1948. 27 pp., diagr., figs. 6 references.

Data from a dynamometer-stand investigation of a 12-cylinder liquid-cooled engine was used as a basis for performance calculations of a compound engine in which a constant-efficiency turbine and an auxiliary supercharger were geared to the engine crankshaft. At a given altitude the ratios of exhaust to inlet-manifold pressure at which maximum net brake horsepower and minimum net brake specific fuel consumption were obtained remained nearly independent of engine speed, fuel-air ratio, inlet-manifold pressure, and component efficiency. This ratio decreased only slightly as altitude was increased from sea level to 45,000 ft. The power of the compound engine increased with altitude up to the tropopause, where it began to decline and the specific fuel consumption decreased with increasing altitude over the entire calculated range, sea level to 45,000 ft. After burning and cooling, a rich-mixture exhaust gas increased the maximum net brake horsepower and decreased the net brake specific fuel consumption.

Effects of Fuel-Nozzle Carbon Deposition on Combustion Efficiency of Single Tubular-Type, Reverse-Flow Turbojet Combustor at Simulated Altitude Conditions. Ralph T. Dittrich. *U.S., N.A.C.A., Technical Note No. 1618*, June, 1948. 27 pp., illus., diagrs., figs. 1 reference.

The range of altitudes was from 20,000 to 45,000 ft. and the range of engine speeds was from 10,000 to 15,000 r.p.m. Fuel-nozzle carbon deposition affected combustion efficiency and a fuel-nozzle shield, which prevented carbon deposition, improved the reproducibility of combustion data.

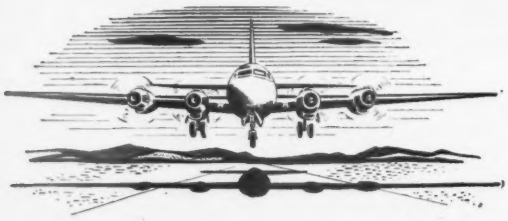
Performance and Design Calculations on Test-Stand Compressor PG 2. Friedrich. (*Ernst Heinkel Flugzeugwerke, He/PG/3*, June, 1941.) *U.S., Air Force, Translation No. F-TS-2742-RE*, March, 1948, 31 pp., figs.

Calculations of the aerodynamic characteristics of a five-stage axial compressor delivering 17 kg. of air per sec. at 27,000 kg. per sq.m. with a speed of 13,000 r.p.m. Strength data given for rotor discs, rotor blades, and torsion shaft.

Conferences on Jet Engines TL 011 and PTL 021. Kollmann. (*Daimler-Benz AG, Nia/6105*, April, 1944.) *U.S., Air Force, Translation No. F-TS-2834-RE*, April, 1948. 13 pp., figs. Minutes of conference on design, development, and production changes for the HeS-011 turbojet and the DB-021 prop-jet engines.

High-Temperature Disk-Forging Developments for Aircraft Gas Turbines. L. B. Fonda. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 1, January, 1948, 1–9, Discussion, pp. 9–12, illus., figs.

A discussion of data obtained from bursting tests of 165 turbine wheels. The program was undertaken to determine the high-speed properties of five alloys—Timken 16-25-6, EME, 19-9-DL, modified Inconel, and CSA—and to establish the effects of production methods on the characteristics of the finished wheel. Ductility was the most important factor contributing to high and



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consistent bursting speed because it permitted the localized stresses induced by minor discontinuities or mechanical defects to be redistributed. Solution-treated wheels were found to burst at extremely high speeds and to undergo considerable cold work during test. A method of prestressing wheel blanks prior to finish machining, therefore, was developed in which an oversize blank was cold-worked by controlled overspeeding. Good ductility can be obtained by controlling the grain flow within the forging. A correlation made of x-ray and Zyglo inspection data with bursting data showed that proper combination of these inspection techniques will reveal defects in the unprocessed forging.

Intake Report. *Flight*, Vol. 53, No. 2056, May 20, 1948, pp. 552–554, illus., figs.

An analysis of the improvement in air intake efficiency obtained with the short-chord and the long-chord ducted spinner over that given by the conventional annular intake. The short-chord ducted spinner was adopted by D. Napier and Sons, Ltd., for their Naiad turbojet design.

Effect of Reducing Valve Overlap on Engine and Compound-Power-Plant Performance. David S. Boman and Samuel J. Kaufman. *U.S., N.A.C.A., Technical Note No. 1612*, June, 1948. 29 pp., figs. 5 references.

To determine the effect of a change in valve overlap on the performance of a compound engine, the performance of a 62°-valve-overlap 18-cylinder, air-cooled, radial engine modified with 40°-valve-overlap cams was compared with the performance of an unmodified engine. At rated power, a reduction of 6 per cent in net thrust horsepower and a reduction of 2 per cent in the net specific fuel consumption of the compound engine were observed at the engine exhaust pressure for maximum net power.

The Effect of Increase in Combustion-Air Inlet Temperature From 80° to 130° F on the Sea-Level Performance of a 22-Inch-Diameter Pulse-Jet Engine. Michael F. Valerino, Robert H. Essig, and Richard F. Hughes. *U.S., N.A.C.A., Memorandum Report No. E6G01 (Wartime Report No. E-283)*, July, 1946. 17 pp., figs. 2 references.

Performance Charts for a Turbojet System. Benjamin Pinkel and Irving M. Karp. *U.S., N.A.C.A., Advance Restricted Report No. E6E14 (Wartime Report No. E-241)*, June, 1946. 51 pp., figs., fold, charts. 4 references.

Charts from which the performance of a turbojet system can be quickly obtained for any given set of operating conditions and system parameters. The charts take into account turbine efficiency, compressor efficiency, combustion efficiency, discharge-nozzle coefficient, losses in total pressure in the inlet duct and combustion chamber, ambient atmospheric conditions, flight velocity, compressor pressure ratio, and combustion-chamber-outlet total temperature. The charts predict actual performance values because factors have been introduced to account for the effect of the change in physical properties of the gas as it passes through the cycle and the effect of the change in the mass by the addition of fuel. The analysis on which these charts are based shows that the maximum thrust per unit mass rate of airflow occurs at a lower compressor pressure ratio than does minimum specific fuel consumption. Increase in combustion-chamber discharge temperature causes an increase in thrust, but an optimum temperature exists at which minimum specific fuel consumption is obtained.

Study of Jet-Propulsion System Comprising Blower, Burner, and Nozzle. Benjamin Pinkel and Eldon W. Hall. *U.S., N.A.C.A., Advance Confidential Report No. E4E06 (Wartime Report No. E-212)*, May, 1944. 39 pp., figs. 2 references.

Thrust Augmentation Boosts Turbojet Engine Performance. Edward Woll. *SAE Journal*, Vol. 56, No. 6, June, 1948, pp. 41–43, figs. (Summary of a paper: Turbojet Engine Performance Characteristics With Reference to Methods of Augmentation.)

Tests of Cast Aluminum-Alloy Mixed-Flow Impellers. John E. Douglas and Irving R. Schwartz. *U.S., N.A.C.A., Memorandum Report No. E6C07 (Wartime Report No. E-277)*, April, 1946. 28 pp., illus., figs. 5 references.

Effect of a Low-Loss Air Valve on Performance of a 22-Inch-Diameter Pulse-Jet Engine. Joseph R. Bressman. *U.S., N.A.C.A., Memorandum Report No. E6E15 (Wartime Report No. E-279)*, June, 1946. 16 pp., figs. 3 references.

Sea-Level Performance Tests of a 22-Inch-Diameter Pulse-Jet Engine at Various Simulated Ram Pressures. Eugene J. Manganiello, Michael F. Valerino, and Robert H. Essig. *U.S., N.A.C.A., Memorandum Report No. E5J02 (Wartime Report No. E-269)*, October, 1945. 38 pp., illus., figs.

Endurance Tests of a 22-Inch-Diameter Pulse-Jet Engine With a Neoprene-Coated Valve Grid. Eugene J. Manganiello, Michael F. Valerino, and John H. Breich. *U.S., N.A.C.A., Memorandum Report No. E5J03 (Wartime Report No. E-270)*, October, 1945. 15 pp., figs. 2 references.

NACA Investigation of a Jet-Propulsion System Applicable to Flight. Macon C. Ellis, Jr., and Clinton E. Brown. *U.S. N.A.C.A., Report No. 802*, 1944. 17 pp., diagrs., figs. 1 reference.

Muffling Noise of Engine Tests. Scholer Bangs. *Aviation Week*, Vol. 48, No. 24, June 14, 1948, p. 20 illus.

Wright's New Facilities for Testing High Output Turbines. *Automotive Industries*, Vol. 98, No. 11, June 15, 1948, pp. 42–44, 74, illus., diagr.

Details on the Westinghouse Jet Development Lab. *Plane Facts*, Vol. 5, No. 5, May, 1948, pp. 7–9, 32, illus.

J35-A-15 Turbo-Jet Engine Production at Allison. Joseph Geschelin. *Automotive Industries*, Vol. 98, No. 11, June 15, 1948, pp. 35–37, illus.

A Spinner for the (Napier) Naiad. *The Aeroplane*, Vol. 74, No. 1948, May 21, 1948, p. 622, illus., fig.

Armstrong Siddeley Mamba Propeller Turbine. *Shell Aviation News*, No. 118, April, 1948, pp. 22–24, illus.

Republic's P-84 Thunderjet Designed Around a Specific Engine Type, the Axial-Flow J-35. Robert McLarren. *Aviation Week*, Vol. 48, No. 21, May 24, 1948, p. 18, illus.

The "Mamba" I Gas Turbine Propeller Engine. *Aero Digest*, Vol. 56, No. 6, June, 1948, pp. 44–46, illus., cutaway drawing.

Details of British Mamba Turbo-Prop. *Automotive Industries*, Vol. 98, No. 11, June 15, 1948, p. 58, cutaway drawing.

RECIPROCATING (6)

Effect of Exhaust Pressure on Knock-Limited Performance of an Air-Cooled Aircraft-Engine Cylinder. Albert M. Lord, Orville H. Heinicke, and Edward G. Stricker. *U.S., N.A.C.A., Technical Note No. 1617*, June, 1948. 22 pp., diagr., figs. 7 references.

Curves show the relation between the ratio of exhaust pressure to inlet-manifold pressure, the inlet-manifold pressure, and the inlet mixture temperature at incipient knock, with corresponding values of indicated mean effective pressure and indicated specific fuel consumption. Knock-limited inlet-manifold pressure and mixture temperature corresponding to constant knock-limited inlet-manifold pressure were less sensitive to change in exhaust-to-inlet-manifold pressure ratio at a fuel-air ratio of 0.080 than at 0.066.

Cylinder-Head Temperatures and Coolant Heat Rejections of a Multicylinder, Liquid-Cooled Engine of 1710-Cubic-Inch Displacement. John H. Povolny and Louis J. Chelko. *U.S., N.A.C.A., Technical Note No. 1606*, June, 1948. 62 pp., illus., diagrs., figs. 4 references.

Data are presented showing variation of cylinder-head temperatures and coolant heat rejection with pertinent engine and coolant variables for power outputs up to 1,860 b.hp., coolant flows from 50 to 320 gal. per min., and wide ranges of engine speed, manifold pressure, fuel-air ratio, inlet-air temperature, ignition timing, exhaust pressure, and coolant composition, temperature, and pressure.

Relation Between Spark-Ignition Engine Knock, Detonation Waves, and Autoignition as Shown by High-Speed Photography. Cearcy D. Miller. *U.S., N.A.C.A., Advanced Restricted Report No. E6C22 (Wartime Report No. E-238)*, April, 1946. 66 pp., figs., tables. 68 references.

A study of the literature on spark-ignition engine knock suggested the combination of the autoignition and the detonation-wave theories into a single theory, according to which knock of a comparatively low pitch may be caused by simple autoignition of end gas at a rate too slow to produce audible gas vibrations. Knock involving both low- and high-pitched tones may be caused by autoignition followed by the development of a detonation wave in the autoignited gases. Knock of high pitch may be caused by a detonation wave in afterburning gases behind the flame front. This wave may also pass through unignited end gas. An analysis of the focal-plane-shutter effect of the N.A.C.A. high-speed camera resulted in a formula to correct for this effect the apparent speed of knock propagation in photographic data. Analysis of five photographs of knocking combustion showed that the explosive knock reaction is a self-propagating disturbance traveling through the last parts of the gas to burn at a speed ranging from about the speed of sound to approximately twice the speed of sound. This speed range is compatible with the proposed combined autoignition and detonation-wave theory but not with

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either of the simple theories of autoignition or detonation of the end gas.

Hydraulic Characteristics of the NACA Injection Impeller. William K. Ritter, Irving A. Johnsen, and Seymour Lieblein. *U.S., N.A.C.A., Memorandum Report No. E6C25 (Wartime Report No. E-278)*, May, 1946. 25 pp., figs. 1 reference.

Effect of Water-Alcohol Injection and Maximum-Economy Spark Advance on Knock-Limited Performance and Fuel Economy of a Large Air-Cooled Cylinder. Jack E. Vandeman and Orville H. Heinicke. *U.S., N.A.C.A., Memorandum Report No. E5H12 (Wartime Report No. E-264)*, August, 1945. 11 pp., figs. 3 references.

Charge-Air Distribution Among the Cylinders of a Double-Row Radial Aircraft Engine. Donald C. Guentert and John G. Ferkan. *U.S., N.A.C.A., Memorandum Report No. E6F27, (Wartime Report No. E-282)*, July, 1946. 15 pp., illus., figs. 6 references.

Effect of Maximum Cruise-Power Operation at Ultra-Lean Mixture and Increased Spark Advance on the Mechanical Condition of Cylinder Components. Herbert B. Harris, Robert T. Duffy, and Robert D. Erwin, Jr. *U.S., N.A.C.A., Memorandum Report No. E5127a (Wartime Report No. E-268)*, September, 1945. 34 pp., illus., figs. 16 references.

Correlation of Mixture Temperature Data Obtained From Bare Intake-Manifold Thermocouples. H. Jack White and Goldie L. Gammon. *U.S., N.A.C.A., Memorandum Report No. E5L03 (Wartime Report No. E-273)*, January, 1946. 17 pp., figs. 5 references.

Air-Flow and Performance Characteristics of Engine-Stage Supercharger of a Double-Row Radial Aircraft Engine. II—Effect of Design Variables. Edmund J. Baas and Paul D. Dugan. *U.S., N.A.C.A., Memorandum Report No. E6G25 (Wartime Report No. E-285)*, August, 1946. 25 pp., figs. 1 reference.

A Preliminary Investigation of the Icing Characteristics of a Large Rectangular-Throat Pressure-Type Carburetor. Gilbert E. Chapman. *U.S., N.A.C.A., Memorandum Report No. E6G11 (Wartime Report No. E-284)*, July, 1946. 11 pp., illus., figs. 1 reference.

Effect of Internal Coolants on The Knock-Limited Performance of a Liquid-Cooled Multicylinder Aircraft Engine With a Compression Ratio of 6.0. R. Lee Nelson, Myron L. Harries, and Rinaldo J. Brun. *U.S., N.A.C.A., Memorandum Report No. E5F30 (Wartime Report No. E-260)*, June, 1945. 27 pp., figs. 1 reference.

Air-Flow and Performance Characteristics of the Engine-Stage Supercharger of a Double-Row Radial Aircraft Engine. I—Effect of Operating Variables. Edmund J. Baas, William R. Monroe, and John M. Mesrobian. *U.S., N.A.C.A., Memorandum Report No. E5H28 (Wartime Report No. E-266)*, August, 1945. 43 pp., figs. 2 references.

First Turbosupercharger Application on Airliner (Boeing 377 Stratocruiser). *Automotive Industries*, Vol. 98, No. 9, May 15, 1948, p. 44, diagr.

A New Pratt & Whitney Twin Wasp (R-2180). *Air World*, Vol. 1, No. 3, p. 72, illus.

From 1700 to 2700 Horsepower in 10 Years; Wright Cyclone 18 Conceived as Simple Combination of Two Nine-Cylinder Engines, But Evolved Into New Unit. *Aviation Week*, Vol. 48, No. 21, May 24, 1948, pp. 26, 27, 31, diagrs.

The Supercharger is Still Here. *Plane Facts*, Vol. 5, No. 4, April, 1948, pp. 22–24, diagr. The function and operation of the internal supercharger and the external turbosupercharger.

Small Cartridge Starters. *Flight*, Vol. 103, No. 2054, May 6, 1948, p. 505, diagr.

The Plessey Company cartridge starters weigh 15 lbs. and are designed for light aircraft. Three standard models give the starter dog a rotation of 380°, 460°, and 580°, respectively.

Some Problems in Connexion with the Development of a High Speed Diesel Engine. H. R. Ricardo. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 210–228, illus.

ROCKET (4)

Adiabatic Flow of Hydrogen Gas Through a Rocket Nozzle With and Without Composition Change. S. S. Penner and D. Altman. *Franklin Institute, Journal*, Vol. 245, No. 5, May, 1948, pp. 421–432, figs. 6 references.

A method for determining the characteristics of adiabatic flow through a rocket nozzle which takes into account the effects of

changes in chemical composition of the fluid due to molecular dissociation. Calculations for the expansion of pure hydrogen gas from a chamber temperature of 3,506°K. at 20.42 atm. to atmospheric pressure indicate that the exhaust velocity and temperature are highest for a flow in which, at both the initial and the final temperature, the reaction $H_2 \rightleftarrows 2H$ is in complete equilibrium. Flow with composition change requires a ratio of nozzle-exit to nozzle-throat area somewhat greater than that determined for adiabatic flow without composition change for the same chamber-pressure to exit-pressure ratio. From the residence time in a given temperature range, which is computed as a function of gas temperature for the two types of flow, the minimum reaction rates can be determined which will allow composition change during flow through the nozzle.

The Rocket as a Weapon of War in the British Forces. Sir Alwyn D. Crow. (The Thirty-Fourth Thomas Hawksley Lecture.) *Institution of Mechanical Engineers, Proceedings*, Vol. 158, No. 1, 1948, pp. 15–21, diagrs., 2 pp. of illus.

Atomic Rocket. *Aviation Week*, Vol. 48, No. 23, June 7, 1948, p. 25.

A proposed design by Kenneth W. Gatland for a rocket that could escape the earth's gravitational field. A single high-temperature atomic pile would heat a working fluid of hydrogen. The forward portion of the ship would consist of a series of fuel tanks which would be jettisoned successively.

Production (36)

Vampire Production; Completion of Fuselage; Wing Structure; Spar Sub-Assemblies. II. S. C. Poulsen. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 190–196, illus., cutaway drawings.

Manufacturing the Percival Prentice. James Hay Stevens. *Aircraft Engineering*, Vol. 20, No. 231, May, 1948, pp. 137, 138, 146, 147, illus., diagrs.

Detailed description of production methods and techniques. Includes four pages of plates illustrating production tools, jigs, special tools, forming processes, and the assembly of components.

Senior Aircraft Manufacturers. Stanley Brogden. *Aircraft*, Vol. 26, No. 8, May, 1948, pp. 12–16, 40, 41, illus. A history of de Havilland Aircraft Pty. Ltd., Australia.

The Industry in Sweden; Some Notes on the SAAB Factory: Large Underground Shops. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 185, 186, illus.

Saab Today; Current Swedish Civil and Military Designs: An Underground Factory. Maurice A. Smith. *Flight*, Vol. 53, No. 2057, May 27, 1948, pp. 575–580, figs.

Furnaces Save Propeller Costs. John D. Waugh. *Automotive Industries*, Vol. 98, No. 9, May 15, 1948, pp. 40–42, 80, 82, 85, illus.

The use of gas and electric furnaces for preheating, normalizing, and heat-treating the work has made it possible to use arc-welded tubular construction for the hubs of Aeromatic variable-pitch propellers and copper brazing to join the head and sleeve of their blade ferrules. Preheating the laminated wood blade has produced a better bond with the plastic blade covering. Tables show the saving in production costs obtained with these methods.

Flash Butt Welding; Experimental Spar-Bracing Tubes for the Bristol Type 167 Aircraft. II—Design of Details; Manufacture of Special Tubes; Set-Up for Weld Tests. S. G. E. Nash, H. Brooks, and M. A. Garnett. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 201–206, illus., diagrs. 5 references.

Cold Welding of Aluminum and Its Softer Alloys; Successful Process Evolved by G.E.C. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 211, 212, illus., diagrs.

A process developed by the General Electric Company's Research Laboratories. Pressure is applied to two contacting uncontaminated metal surfaces in a relatively narrow region with a hand press. The dies are designed to permit the metal to flow from both sides of the weld. Successful results have been obtained with soft aluminum alloys, copper, and nickel.

The Machining of Stainless Steels. W. H. Crisp and W. Burnan. *Aircraft Engineering*, Vol. 20, No. 231, May 1948, pp. 151–153, figs.

The design of cutting tools, recommended cutting speeds and feeds, lubricants, and techniques that will minimize the problem of chip and swarf clearance in the rough turning, finish machining, drilling, reaming, tapping, threading, milling, and cold sawing of austenitic, ferritic, and martensitic stainless steels.

Bath Contour Forming, a New Metalworking Process. *Automotive Industries*, Vol. 98, No. 11, June 15, 1948, pp. 32, 33, 67, illus., diagrs.

Use of "Glass Blanket" Prevents Metal Sticking on Stretch Forming Dies. *The Martin Star*, Vol. 7, No. 5, June, 1948, p. 8, illus.

The Proficorder—An Instrument for Recording Waviness and Other Surface Profiles. E. J. Abbott and Edward Rupke. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 263–269, Discussion, pp. 269, 270, figs.

Radiographs; "Relief" Method for Facilitating Interpretation. *Aircraft Production*, Vol. 10, No. 116, June, 1948, p. 200, illus.

Bore Inspection; Fine Measurement of Interrupted and Soft-Surfaced Bores: New Method Evolved at A.I.D. Test House, Harefield. *Aircraft Production*, Vol. 10, No. 116, June, 1948, pp. 187, 188, illus., fig.

Screw Gauging; Triple-Purpose Combination Gauge for External Threads. *Aircraft Production*, Vol. 10, No. 116, June, 1948, p. 207, diagr.

Better Packing at Lower Cost. E. P. Troeger. *Distribution Age*, Vol. 47, No. 5, May, 1948, pp. 32, 33, 120, illus. A summary of the factors that determine the lowest cost container that will give the required protection.

Swarf Disposal; Conveyor System for Battery of Spar-Millers. *Aircraft Production*, Vol. 10, No. 116, June, 1948, p. 199, illus.

Propellers (11)

Analytic Study of the Supersonic Propeller (Project No. AP-277). F. Weinig. *U.S., Air Force, Technical Report No. F-TR-1176-ND (GS-USAF Wright-Patterson Air Force Base No. 84)*, April, 1948. 57 pp., figs. 3 references.

The mean drag-to-lift ratio along the blade was used to estimate the maximum ratio obtainable at various Mach Numbers for a number of profile ratios. Some results showed that, at the higher flight velocities, sufficient aerodynamic efficiency was obtained for the propeller to yield a flight velocity of Mach 2. The low efficiency noted in the transonic range was susceptible to considerable improvement by the use of sweptback blades. Structural problems appear to determine the practical limit of propeller application. For straight blades this limit seems to be near a flight velocity of Mach 2 while sweptback blades seem to be practicable in the vicinity of Mach 1.1. Best results will probably be obtained with a small number of blades, a moderate hub-to-tip ratio, and duplex (biplane) blades. Since at moderate supersonic flight velocities, because of the influence of the fuselage and the hub, the propeller may be working in a subsonic region behind a detached shock wave, it is probable that the aerodynamic problems of the propeller may be considered by themselves, at least when the supersonic velocity is substantially lower than the flight velocity. If special provision is made for using the exhaust jet at higher velocities to supply extra thrust during take-off and climb, the difficulties presented by the variable-pitch propeller may be avoided. However, before all the potentialities of the propeller are made available at high velocities, it will be necessary to conduct considerably more extensive wind-tunnel testing and to develop propeller theory and methods of computation.

Is the Propeller Here to Stay? Carl F. Baker. *Air World*, Vol. 1, No. 3, pp. 54–59, illus., figs.

A survey of the operating costs, range, and pay loads of propeller-powered and thermal-jet aircraft throughout their ranges of velocities shows that the optimum velocity for the majority of all cargo and transport aircraft lies between 100 m.p.h. and sonic velocity. Because of the greater inherent efficiency of the propeller in this range these craft will have conventionally designed propellers as their propulsion device regardless of type of power plant.

The Theory of Propellers. Theodore Theodorsen. *U.S., N.A.C.A.*, U.S. Govt. Printing Office, Washington.

I—Determination of the Circulation Function and the Mass Coefficient for Dual-Rotating Propellers. *Report No. 775*, 1944. 17 pp., illus., figs. 3 references. $0.15.

II—Method for Calculating the Axial Interference Velocity. *Report No. 776*, 1944. 21 pp., figs. $0.20.

III—The Slipstream Contraction With Numerical Values for Two-Blade and Four-Blade Propellers. *Report No. 777*, 1944. 23 pp., figs. 1 reference. $0.20.

IV—Thrust, Energy, and Efficiency Formulas for Single- and Dual-Rotating Propellers With Ideal Circulation Distribution. *Report No. 778*, 1944. 7 pp., figs. 3 references. $0.15.

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New (Hamilton Standard) Hydromatic Propeller Reverses Blade Pitch. Carl F. Baker. *SAE Journal*, Vol. 56, No. 6, June, 1948, pp. 21–23, figs. (Summary of a paper: The Reversing Hydromatic and Its Control.)

Rotating Wing Aircraft (34)

Stress Analysis of a Helicopter Rotor. G. von Sissingh. (*Göttingen, Aerodynamische Versuchsanstalt, ZWB/UM/3143*, August, 1944.) *U.S., Air Force, Translation No. ATI-19597*, June, 1948. 25 pp., figs.

The lift and stress distribution on the blades of the two coaxial rotors of the BHN helicopter were determined with no wind, in a constant up-wind velocity of 10 m. per sec., and in a horizontal wind of 20 m. per sec. for a rated rotor speed of 450 r.p.m. The up-wind reduced the maximum bending stress in the blade calculated under no wind conditions by about 12 per cent, and a further decrease was brought about by a horizontal wind. The periodic alterations in the lift distribution in a horizontal wind introduced considerable bending stresses.

Results of the Aerodynamic and Blade Loading Computation of the Rotor of the Cierva Autogiro C 30 A. Kochanowsky. (*ZWB/FB/592*, April, 1936.) *U.S., Air Force, Translation No. F-TS-5407-RE (ATI-19595)*, May, 1948. 9 pp., figs.

Aerodynamic computations for the rotor of a Cierva gyroplane C 30 A at speeds of 220 and 235 r.p.m. were made according to Wheatley's method outlined in *N.A.C.A. Report No. 487* to verify its validity. The calculations agreed well with flight-test measurements. Blade loadings in forward flight at 87 and 167 km. per hour and 815 kg. gross weight, gave a basic bending moment stress of 55 kg. per sq.mm. at the higher speed when the blade is assumed to be rigid. When flexibility of the blade was taken into account the static part of the bending moment was reduced about 87 per cent. This reduction was considerably offset by the dynamic effects of the flexibility.

Standard Symbols for Helicopters. Alfred Gessow. *U.S., N.A.C.A., Technical Note No. 1604*, June, 1948. 13 pp., figs.

A list of symbols most generally used in helicopter aerodynamic studies. The list, compiled and correlated from those that have appeared in many papers on rotating wing aircraft, has been approved by the N.A.C.A. Subcommittee on Helicopters. An appendix explains the meaning and significance of axis of no feathering.

Chordwise and Beamwise Bending Frequencies of Hinged Rotor Blades. Gabriel Horvay. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 497–502, figs. 5 references.

An investigation of the low-frequency chordwise and beamwise natural frequencies of a helicopter blade yielded parameters that permitted any chordwise natural frequency to be expressed in terms of the fundamental frequency of the nonrotating blade. Since these frequency parameters are rather insensitive to variations in the mass and moment of inertia distribution and the plan form of the blade, the determination of the coefficients for one particular blade permits an estimate of the various frequencies of other blades of similar design once their fundamental nonrotating frequency is known. These parameters are evaluated for the 23-ft. McDonnell blade.

Flight Testing of Helicopters. W. Stewart. *Royal Aeronautical Society, Journal*, Vol. 52, No. 449, March, 1948, Discussion, pp. 293–304, illus., figs. 12 references.

The nature of the flow through the rotor disc under the three working conditions—the propeller working state, the vortex ring, and the windmill brake state—is the fundamental information required for performance estimation for the solution of problems of stability and control. This information was obtained by making the streamlines visible with filaments of smoke which permitted measurements to be made at any point in the slipstream and related to the appropriate radial position at the rotor disc. Satisfactory agreement with theory was obtained within the experimental limitations of the slipstream swirl measurements. The various performance tests discussed show the difficulty of obtaining accurate measurements at the low speed of the helicopter and the problem caused by the large interference effects due to the rotor flow. A general discussion of the stability and control characteristics of a single rotor helicopter shows the need for special instrumentation, flight technique, and methods of analysis. The ability of the helicopter to fly in adverse weather under conditions of limited visibility would make it well suited for blind flight were it not for its unsatisfactory dynamic stability under stick-free conditions.

Analysis of Flight-Performance Measurements on a Twisted, Plywood-Covered Helicopter Rotor in Various Flight Conditions. F. B. Gustafson and Alfred Gessow. *U.S., N.A.C.A., Technical Note No. 1595*, June, 1948. 42 pp., illus., figs. 12 references.

Both the forward flight and the hovering performances of the alternate rotor were within a few per cent of the values predicted by existing theory without any increase in the profile-drag characteristics originally assumed by the theory when blade-section stalling was not present. A marked improvement was shown in all flight conditions, half of which was attributed to the improved airfoil-section contour and surface condition and the other half to the differences in twist and solidity between the original and the alternate rotors.

The Power Requirements of the Ideal Helicopter. G. von Sissingh. (*Göttingen, Aerodynamische Versuchsanstalt.*) *U.S., Air Force, Translation No. F-TS-5408-RE*, April, 1948. 6 pp. 2 references.

The momentum theory is applied to the helicopter to determine the best glide ratio and optimum flight speed and to establish a method by which actual efficiency may be compared with ideal efficiency. Power requirements are analyzed in terms of the vertical thrust, forward thrust, rotor area, parasitic drag, velocity, and air density.

Investigation of a Helicopter Model. III. H. G. Kuessner. *U.S., Air Force, Translation No. F-TS-5487-RE*, April, 1948. 8 pp.

Description of a remote indicating system for obtaining seven-component wind-tunnel measurements of helicopter models. Results are given of tests with three types of blade attachment to determine their effectiveness in eliminating the influence of rolling moment on other rotor reactions.

Helicopter Control and Stability in Hovering Flight. R. H. Miller. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 453–472, figs. 6 references.

The stability and control characteristics of several different types of helicopters have been evaluated and compared with the characteristics of a conventional airplane. Some form of automatic stabilization is indicated if more desirable handling qualities are to be attained, but, if stability is not to be achieved at the expense of controllability, means of increasing the control effectiveness is evidently necessary. In some cases, response and stability characteristics approaching those of an airplane may be achieved. The equations of motion for the helicopter and rotor blades have been developed in nondimensional form in such a way as to include the effects of flapping and feathering hinge offsets and restraint about these hinges. Both single- and twin-rotor helicopters have been considered, and the complete solution has been simplified without a loss of accuracy, wherever possible. The effects of automatic stabilization have been included in the solution in a manner that should cover most applications. An elementary servo system has been analyzed by means of the frequency response method.

The Danger of the Side Drift Landing in the Operation of Rotary Wing Aircraft. S. Hoerner. (*Deutsche Versuchsanstalt für Luftfahrt*, February, 1936.) *U.S., Air Force, Translation No. F-TS-5406-RE*, April, 1948. 5 pp., figs. 6 references.

Approximate calculations of the tendency of rotary-wing aircraft to tip over sideways during cross-wind landings were made for the Cierva C.19 and C.30 autogyros. These craft tip over in a cross wind of 5 m. per sec. if the drift angle exceeds about 30°. If the wind velocity is increased to 10 m. per sec., the C.19 will turn over at a drift angle of 12° and the C.30 at 14°.

Ramjets for Helicopters. Allyn B. Hazard. *American Helicopter*, Vol. 10, No. 6, May, 1948, pp. 10–12, 21, 22, figs.

The theoretical performance of a ram-jet engine designed for a helicopter power plant. A plot of the thrust against the velocity of a subsonic ram-jet and curves for the corresponding values of thrust horsepower, fuel consumption, overall efficiency, ratio of the exhaust area to the intake area, and the fuel-air ratio are combined in a single graph. The plot assumes an intake area of 1 sq.in. and ignores drag, but by using correction factors it may be used to design any ram-jet. An example illustrates its use.

Marquardt Jets. Corwin D. Denney. *American Helicopter*, Vol. 10, No. 6, May, 1948, pp. 16, 17, 23, diagrs.

A general description of the pressure type of jet propulsion system and the ram-jet system developed by Marquardt Aircraft Company for helicopters. These power plants are compared with

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that of the conventional helicopter on the basis of increased pay load and endurance. They are able to carry a greater pay load for periods of time up to approximately 2 hours.

The U.S. Navy's Helicopter Program. J. W. Bunkley. *American Helicopter*, Vol. 11, No. 7, June, 1948, pp. 10, 11, illus.

Whirling-Arm Test Rig Developed for Helicopter Blades (Rotawings Division, The Glenn L. Martin Co.). *The Martin Star*, Vol. 7, No. 5, June, 1948, pp. 2, 12, illus.

Coaxial Design Promises Success (Bendix Model K Single-Seater and Model J Five-Seater). Irving Stone. *Aviation Week*, Vol. 48, No. 20, May 17, 1948, pp. 21, 22, 24, illus.

Pilot Instruction on the Hoppi-Copter. James H. Louie. *American Helicopter*, Vol. 10, No. 6, May, 1948, p. 15.

The Irvin-Bell 47B; A Two-Seater Helicopter with "Sports Car" Characteristics. *Flight*, Vol. 53, No. 2054, May 6, 1948, pp. 500–502, illus., cutaway drawings.

Fairey Gyrodyne. J. A. J. Bennett. *American Helicopter*, Vol. 11, No. 7, June, 1948, pp. 13, 14, 22, 23, illus.

Sciences, General (33)

MATHEMATICS

Solution of General Linear Characteristic Value Problems. Wielandt. (*Göttingen, Aerodynamische Versuchsanstalt, B/44/J/19*, August 1, 1944.) *U.S., Air Force, Translation No. F-TS-976-RE (ATI-18804)*, May, 1948. 7 pp.

Proof of convergence cannot be obtained in the iteration method for the numerical solution of eigenvalue problems containing asymmetrical nuclei by the assumption that the selected initial function can be developed into an absolutely uniformly convergent series with respect to the eigenfunctions. This difficulty can be overcome by formulating an inhomogeneous equation, the solution of which is expressed as a Neumann series. Convergence can then be established by the general theorems of the theory of functions.

Some Bessel Equations and Their Application to Guide and Cavity Theory. Morris Kline. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 37–48, figs. 12 references.

Establishes mathematically the existence of roots of two Bessel function equations,

$$J_n(x)N_n(\rho x) - J_n(\rho x)N_n(x) = 0, \qquad n = 0, 1, 2, 3 \ldots \quad (1)$$

and

$$J_n'(x)N_n'(\rho x) - J_n'(\rho x)N_n'(x) = 0, \qquad n = 0, 1, 2, 3 \ldots \quad (2)$$

for ρ near 0. Generally, for all roots and all orders of the Bessel functions, as ρ approaches 0, the first root of Eq. (1) for $n = 0$ approaches the first root of $J_0(x) = 0$; likewise, the first and second roots of Eq. (2) for $n = 1$ approaches the first and second roots, respectively, of $J_1'(x) = 0$. A one-to-one correspondence is shown for the positive roots of $J_n(x) = 0$ and solutions of Eq. (1) and for the positive roots of $J_n'(x) = 0$ and the solutions of Eq. (2) for small ρ. These facts have application in electromagnetic wave guide and cavity theory. The existence and ordering of coaxial, circularly cylindrical modes has meaning only in terms of the existence and ordering for a given n of the solutions of Eqs. (1) and (2) and can be established from the solutions for small ρ. A one-to-one correspondence exists between the coaxial modes, other than the principal or TEM mode and the circular ones. The field of each coaxial mode approaches the field of the corresponding circular mode as ρ approaches 0, and the field of a circular mode is disturbed only slightly by the introduction of a thin inner conductor. Hence, quantities such as cutoff and resonant frequencies for modes in coaxial structures with thin inner conductors may be approximated by the corresponding quantities for the corresponding modes in circular structures.

Applications of Tensor Analysis to Elasticity and Piezoelectricity. Jacob Harry Jurmain. *Franklin Institute, Journal*, Vol. 245, No. 6, June, 1948, pp. 475–500, fig. 9 references.

Dimensional Analysis: An Approach From Transformation Theory and a Criterion for Scaling Model Experiments. J. C. Decius. *Franklin Institute, Journal*, Vol. 245, No. 5, May, 1948, pp. 379–387. 4 references.

A Mechanical Integraph for the Numerical Solution of Integral Equations. Peter L. Tea. *Franklin Institute, Journal*, Vol. 245, No. 5, May, 1948, pp. 403–419, figs. 17 references.

Auxiliary Table for the Incomplete Elliptic Integrals. E. L. Kaplin. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 11–36. 6 references.

Interpolation into Legendre's tables of the incomplete elliptic integrals F and E is not practicable when both the modular angle $\sin^{-1}k$ and the amplitude φ are near 90°. Easily interpolable functions are derived and tabulated from which the integrals may be calculated in this case. The relevant formulas and a new list of errata for Legendre's tables are given.

On the Determination of the Eigenfunctions of Fredholm Equations. G. F. Carrier. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 82, 83. 2 references.

Table of Roots for Natural Frequencies in Coaxial Type Cavities. H. B. Dwight. *Journal of Mathematics and Physics*, Vol. 27, No. 1, April, 1948, pp. 84–89. 5 references.

MECHANICS

Calculation of Frequencies of Truncated Pyramids. H. D. Conway. *Aircraft Engineering*, Vol. 20, No. 231, May, 1948, p. 148. A development of formulas for the longitudinal, flexural, and torsional vibration of truncated pyramids, encastré at one end, free at the other, composed of homogeneous, isotropic materials.

Rectangles—Area and Moments of Inertia. Serge Alexeeff. *Aero Digest*, Vol. 56, No. 6, June, 1948, p. 80, figs.

The Hydrodynamics of Non-Newtonian Fluids. I. R. S. Rivlin. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 260–281. 4 references.

A hydrodynamic theory applicable to macromolecular materials, colloids, and highly viscous fluids which does not impose the stress-strain-velocity relationships implied by the classical theory. The fluid is assumed to be incompressible, visco-inelastic, and isotropic when all components of the strain-velocity, as classically defined, are zero. The kinematics of flow and the most general possible form of the stress-strain-velocity relations under these assumptions are developed, and the equations of motion and boundary conditions are established. The theory is applied to two simple problems involving steady-state laminar flow; the torsional motion of a cylindrical mass of fluid, produced by forces applied to the plane ends; and the torsional motion of a mass of fluid between infinite coaxial cylinders rotating with different angular velocities about their common axis. The relations between the force system and flow velocity and the resulting stress distribution in the fluid that are derived show that, in general, normal tractions must be applied to the plane surfaces of the fluid, in addition to the azimuthal tractions expected from the classical theory, in order to produce the specified motion. These results apply even when centrifugal forces are neglected and so imply a qualitative difference between the behavior of fluids in general and those for which the special case of classical hydrodynamics is valid.

Stress Analysis & Structures (7)

Relaxation Methods Applied to Engineering Problems. XIII—The Flexure and Extension of Perforated Elastic Plates. R. V. Southwell. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 147–171, figs. 7 references.

The theory given in Part VIIA for a flat plate having a single external boundary is extended to allow for internal boundaries (holes) at which, as well as at the external boundary, either tractions or displacements may be specified. Such holes entail appreciable complication, especially when boundary tractions are specified, and do not form an equilibrating system at each hole severally; "orthodox" studies (e.g., by Bickley, Green, Howland, Jeffery) have been restricted to simple shapes (e.g., one or more circular holes in a plate having infinite extension). However, any shape can be treated by relaxation methods, without excessive labor and with all the accuracy that has practical value. A worked example (stresses in a loaded tie-bar) shows that holes may entail a cyclic form for Airy's stress-function χ.

Three-Dimensional Stress Systems in Isotropic Plates. II. A. E. Green and T. J. Willmore. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 229–248 figs. 7 references.

The problem of an isolated force uniformly distributed through a plate of finite thickness and acting parallel to the faces of the plate, which are free from applied stress, is solved in integral form. Numerical work is carried out for the average value of the stresses in order to compare the results with those found from the approxi-

mate theory of generalized plane stress. Numerical values of the stresses are found on the faces of the plate and on the plane midway between the faces.

On the Use of Power Laws in Stress Analysis Beyond the Elastic Range. Alice Winzer and W. Prager. **Discussion.** S. B. Batdorf and E. Z. Stowell. W. P. Roop. J. Twyman. P. F. Chenea. *Journal of Applied Mechanics*, Vol. 15, No. 2, June, 1948, pp. 185–187, figs. 4 references. (Cf. AER 4/48:71.)

Letter to the Editor. F. R. Shanley. *Journal of the Aeronautical Sciences*, Vol. 15, No. 8, August, 1948, pp. 502, 503, fig.

In the paper, "Inelastic Column Theories and an Analysis of Experimental Observations" (JOURNAL OF THE AERONAUTICAL SCIENCES, May, 1948), Professor Wang used the "coefficient of fixity" as a multiplying factor for the critical column load in the inelastic range. This gives too high a predicted load. Since the end restraint reduces the effective column length, its effect should be taken care of by a factor that operates on the column length, rather than on the load or stress.

Strength and Failure Characteristics of Thin Circular Membranes. W. F. Brown, Jr., and George Sachs. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 2, April, 1948, pp. 241–249, Discussion, pp. 249–251, figs. 19 references. A theoretical and experimental analysis of the hydraulic bulging of a thin circular membrane. The circular membrane was found to permit the stress-strain curve to be followed to high strains without serious necking or localization and to offer a simple experimental method for straining metal in sheet form under uniform biaxial load. The instability phenomena encountered in the deformation of this shape are analyzed in terms of strain distribution and by equations that relate the stress-strain and the radius-strain functions.

Aircraft Vibration and Flutter Research in Germany. U.S. Naval Technical Mission in Europe. *Gt. Brit., British Intelligence Objectives Sub-Committee, Miscellaneous Report No. 61 (Technical Report No. 364–45)*, October, 1945. 69 pp., figs. 63 references.

Organization of the vibration and flutter research personnel of the Junkers, Dornier, Messerschmitt, and the Focke-Achgelis (helicopter) air-frame producers. The methods, instrumentation, and techniques used by each in ground-vibration tests, flight-flutter tests, wind-tunnel model testing, and free-flight testing are summarized. At Göttingen, flutter research included the development of basic aerodynamic theory, the calculation of aerodynamic coefficients for high Mach Numbers, and water-tunnel check tests. Three special reports are included. One details the practice of Junkers. The others outline the practical and theoretical work conducted by Messerschmitt and summarize the flutter calculations made in the course of development of the Me 262.

Test Flights on the Ground; Testing the Scandia Before Flying. Lars-Axel Stromberg. *Saab Sonics*, No. 2, April–June, 1948, pp. 19–24, illus., diagr.

A new type of aircraft is subjected to extensive tests before it is tested in actual flight. The large dimensions of the Scandia rendered the work of calculation difficult in some respects, but testing was facilitated because the plane was built in accordance with known constructional principles. Strength test. Fixed and detachable wing joints. Loading to failure of vital light-metal parts. A total test and the advantages derived from it. Electric strain gages imported from the U.S.A. Air and mass forces on the wings are taken up by a link system of steel wires. Operating test. Apparatus test. Testing the fuel system, the deicing installation and the "bad weather" screen. Landing gear test, spin-up test. Investigations relating to flutter in the rudder. The ground tests are continued after the first flight.

Notes on the Lagrangian Multiplier Method in Elastic-Stability Analysis. Bernard Budiansky, Pai C. Hu, and Robert W. Connor. *U.S., N.A.C.A., Technical Note No. 1558*, May, 1948. 46 pp., figs. 8 references.

The proper selection of Fourier series to express the elastic stability of clamped plates in shear and plate stiffener combinations makes it possible to solve for infinitely many Fourier coefficients in terms of Lagrangian multipliers. While it is possible to obtain an exact solution only for an infinitely long plate, an approximate solution for a finite plate may be obtained in two different ways. This permits the computation of an upper, as well as a lower, limit to the true critical stresses.

Effect of Shear Lag on Bending Vibration of Box Beams. Roger A. Anderson and John C. Houbolt. *U.S., N.A.C.A., Technical Note No. 1583*, May, 1948. 15 pp., figs. 3 references.

A method that includes the effects of shear lag in the determination of the bending modes and frequencies of wings that are designed essentially as shallow box beams. Calculations indicate that, although only a small shear-lag action may be observed in a simple static deflection test of the beam, reductions in the second and higher mode frequencies may be relatively large.

Experimental Investigation of the Effects of Concentrated Weights on Flutter Characteristics of a Straight Cantilever Wing. Harry L. Runyan and John L. Sewall. *U.S., N.A.C.A., Technical Note No. 1594*, June, 1948. 39 pp., illus., figs.

Results of flutter tests made in the Langley 4.5-ft. flutter research tunnel on a uniform, untapered model wing by mounting concentrated weights which were 38, 60, 90, and 100 per cent wing weight. The wing was mounted as a rigid cantilever. The moment of inertia, position of the chordwise center of gravity of the weight, and spanwise location of the weight were varied. Information is provided whereby the validity of existing theoretical analyses may be evaluated by comparison with experimental results.

Stress Notch Sensitivity With Eccentric Holes. L. Schapiro and R. H. Esling. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 2, February, 1948, pp. 135–138, figs.

Moseley's expression for eccentricity is used in a three-dimensional plot relating the notch-strength ratio, removed area, and its eccentricity. An equation is derived for the three-dimensional surface of relationship and the stress notch sensitivity of 24S-T and 14S-T aluminum alloys is compared on the basis of the constants of their respective equations of relationship. The result of static-tension loading-to-rupture tests indicated that the relative stress notch sensitivity of the three alloys was the same with eccentric holes as with central holes or external notches.

Strength Tests of Shear Webs With Uprights Not Connected to the Flanges. Charles W. Sandlin, Jr. *U.S., N.A.C.A., Technical Note No. 1635*, June, 1948. 10 pp., figs. 2 references.

Charts for the Determination of Wing Torsional Stiffness Required for Specified Rolling Characteristics or Aileron Reversal Speed. Henry A. Pearson and William S. Aiken, Jr. *U.S., N.A.C.A., Report No. 799*, 1944. 10 pp., figs. 13 references. U.S. Govt. Printing Office, Washington. $0.15.

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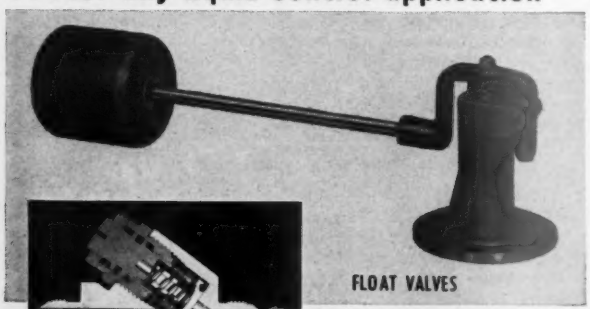

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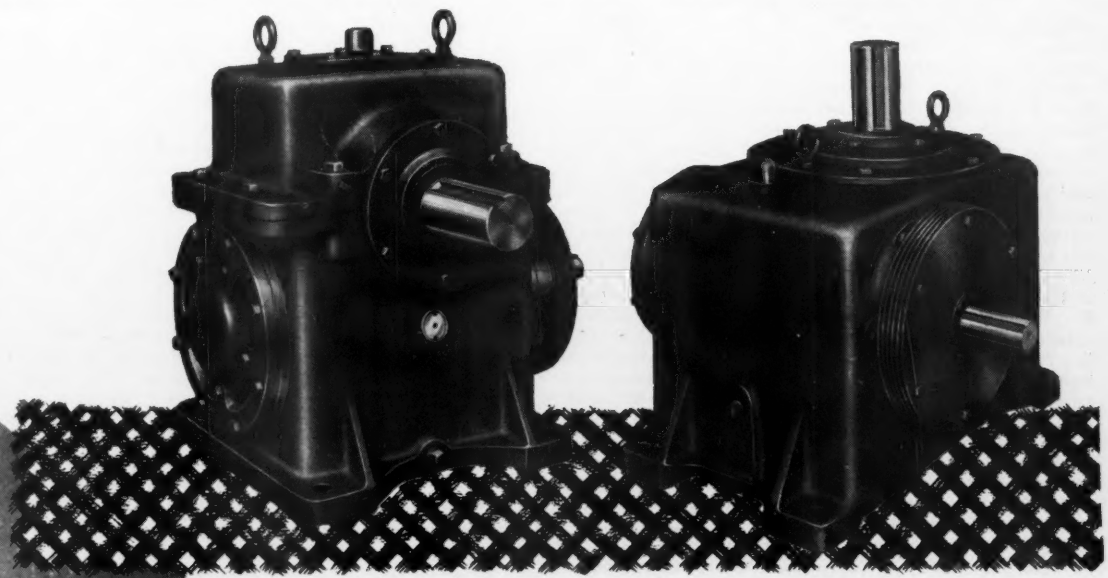

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Effect of Hinge-Moment Parameters on Elevator Stick Forces in Rapid Maneuvers. Robert T. Jones and Harry Greenberg. *U.S., N.A.C.A., Report No. 798*, 1944. 8 pp., figs. 3 references. U.S. Govt. Printing Office, Washington. $0.15.

Application of Spring Tabs to Elevator Controls. William H. Phillips. *U.S., N.A.C.A., Report No. 797*, 1944. 14 pp., figs. 5 references. U.S. Govt. Printing Office, Washington. $0.15.

A Worked Example for the Centre of Gravity of a Tricycle Type Aircraft. *The Technical Instructor*, Vol. 3, No. 5, May, 1948, p. 20, diagr.

The Loads on Tricycle Landing Gears in Landings. I, II. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S. 244, S.245.* 7 pp. (In English.)

A supplementary guide to the Dutch text of two reports of the same title which gives the English reader the basic assumptions, a summary of the conclusions, an outline of the development of the investigation through each step in the original research, and an explanation of the equations.

A Strain-Sensitive Resistance Wire Manometer. A. G. Keenan and R. L. McIntosh. *Review of Scientific Instruments*, Vol. 19, No. 5, May, 1948, pp. 336–339, figs. 25 references.

Design of a laboratory instrument in which the load applied to a metal bellows is measured by a strain-sensitive wire. Sensitivities from 0.003 mm. Hg, in the range 0–12 mm., to 0.8 mm. Hg, in the range 0–200 mm., were obtained. The gage displayed hysteresis and poor reproducibility, which were, in a large part, due to the characteristics of the wire used.

Thermodynamics (18)

The Limits of Flame Propagation at Atmospheric Pressure. I—The Influence of "Promoters." II—The Influence of Changes in the Physical Properties. Sir Alfred Egerton and J. Powling. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1033, May 27, 1948, pp. 172–190; 190–209; figs. 14, 28 references.

I. Investigation of the effect on the flame propagation in upper-limit and lower-limit mixtures of hydrogen and air, methane and air, and *n*-butane (propagas) and air, of such promoters and inhibitors as ethyl nitrate, diethyl peroxide, nitrogen peroxide, ozone, ether, acetaldehyde, ethyl alcohol, and methyl iodide, showed that the presence of promoters in the gas ahead of the flame had little specific influence on the propagation limits. The main criterion for inflammation appeared to be the maintenance of a rate of reaction and heat release in the flame sufficient to provide enough active radicals to inflame the entering gases. After inflammation occurs, the additives may influence the flame characteristics, particularly in the upper-limit region. Only with methyl iodide (inhibitor) and ethyl nitrate (promoter) was there any indication of action prior to entry. Even in those cases the action might have been due to an influence on the rate of reaction in the flame and therefore on the flame boundary temperature. **II.** The effect of replacing the nitrogen of the air by other diluents, such as CO_2, A, and He on the limits of propagation of flame in hydrogen and methane mixtures showed that whether combustion takes place or not depends on the temperature of the flame being sufficient to maintain a boundary flame temperature that will provide an adequate concentration of active radicals in the boundary region. Inflammation in the unburnt gas is caused by these radicals. While exceptional for limit mixtures, the possibility of a double process occurring, one due to cool flame reactions in the unburnt gas and the other due to the active radicals, is not precluded. This absence of reaction in the unburnt gas does not hold necessarily for fast-burning mixtures. This premise, however, enables the approximate estimation of whether a given mixture of combustibles and diluents should propagate flame, provided the specific heats and the character of the reaction is known.

The Influence of Reaction Interface Extension in the Combustion of Gaseous Fuel Constituents. W. J. Wohlenberg. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 2, April, 1948, pp. 143–156, Discussion, pp. 156–160, figs. 10 references.

A model of a combustion chamber is erected in which the air and the gaseous fuel are considered to exist as islands rich either in oxygen or in fuel molecules. These zones are separated by reaction interzones into which the molecules from the zones of concentration diffuse and then react according to the kinetics of molecular collisions. Turbulence causes the original large concentration zones to be broken up into many smaller zones and creates jagged eddied interface surfaces along the combustion path. The essential geometrical characteristic, to which the energy release rate per unit volume of the combustible mixture is proportional, is the extent of the interzone per unit volume of the mixture. This extent factor is the area per unit volume of an imaginary interface within the interzone. An analytical evaluation of the reaction rate is made based on molecular diffusion, kinetics of molecular collisions, and the reaction interface area. The primary variables are expressed, insofar as possible, as functions of the temperature, pressure, and velocity of the gases in the combustion chamber and the fuel-to-air ratio. The extension of the reaction interface influences the magnitude of the pressure and temperature effects on the reaction rate for combustible mixtures. Equations are obtained for the reaction rate and combustion progress in which the reaction interface extension is taken as one of the coordinates on which the rate of the reaction per unit volume depends. From these equations the order of magnitude may be established of the maximum possible mean energy release rates over a given combustion progress. The equations are applied to natural gas and air mixtures of various fuel-air ratios.

High-Output Combustion of Ethyl Alcohol and Air. A. H. Shapiro, D. Rush, W. A. Reed, D. G. Jordon, and G. Farnell. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 2, April, 1948, pp. 161–169, figs. 18 references.

Test results of the combustion of a mixture of ethyl alcohol and water with air at a pressure of 475 lbs. per sq.in. atm. Excess fuel was used to control the exhaust-gas temperature between 1,350° and 2,050°F. The combustor was designed to give combustion intensities up to 11×10^6 B.t.u. per hour per cu.ft. Theoretical calculations based on the assumption of chemical equilibrium at the temperature of adiabatic combustion were in moderately good agreement with the relations observed between the thermodynamic properties and gas temperature, fuel-air ratio, isentropic enthalpy drop obtainable from the combustion gas, and gas composition. A condition approximating "frozen" equilibrium was observed to set in at about 2,500°F. The isentropic enthalpy drop was determined from direct measurement of the thrust and from analyses of the exhaust gas. Both methods gave reliable results.

Ignition and Flame Stabilization in Gases. Bernard Lewis and Guenther von Elbe. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 4, May, 1948, pp. 307–316, figs.

A discussion of ignition, combustion, and flame stabilization. Self-ignition of a fuel-air mixture may be caused by acceleration of the chemical reaction of the components by increased temperature. It may also occur as a branched-chain explosion in which the chemical reaction is accelerated by the formation of chemically active particles at a rate in excess of their rate of destruction. Local ignition results in the formation of a combustion wave that propagates through the explosive mixture in a manner analogous to Huyghen's principle for the propagation of a light wave. The minimum ignition requirement of electric capacitance sparks in hydrocarbon-oxygen-nitrogen mixtures is the spark energy alone. The minimum spark-ignition energy is shown to be a function of the burning velocity, the width of the combustion wave, and other variables of the gas mixture. A flame becomes stable when the burning velocity is equal to the gas velocity somewhere in the combustion wave and nowhere exceeds the gas velocity. The limits for flashback and blowoff correspond to critical values of the gas-velocity gradient at the stream boundary.

Thermodynamics. II—Work, Heat, and Temperature Concepts, and an Examination of the Temperature Scale. J. L. Finck. *Franklin Institute, Journal*, Vol. 245, No. 5, May, 1948, pp. 365–378. 5 references.

Water-Borne Aircraft (21)

Wind-Tunnel Investigation of a Systematic Series of Modifications to a Flying-Boat Hull. Felicien F. Fullmer, Jr. *U.S., N.A.C.A., Technical Note No. 1576*, May, 1948. 37 pp., illus., figs. 8 references.

It was found that substantial drag reductions were possible by reducing the depth of step and by rounding parts of the chines. One configuration, having an auxiliary longitudinal step and a shallow transverse step, was investigated as a compromise arrangement having lower drag and was believed to be hydrodynamically practical.

Save Your Seaplane. Lee Irwin. *Skyways*, Vol. 7, No. 6, June, 1948, pp. 30–32, 49, 58, 59, illus.

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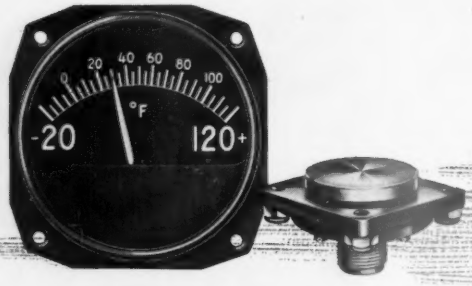

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Wind Tunnels (17)

Die Messtechnik im Peenemünder (Kocheler) Ueberschallkanal (Measurement Technique in the Peenemunde (Kochel) Supersonic Tunnel). S. F. Erdmann. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. A.1024,* September 30, 1946. 53 pp., figs. (In German.)

The instrumentation of the supersonic wind tunnel used during tests of development models of the V-2, the A-9, and the V-3 guided missiles. In addition to three-component measurements that were made with a mechanical and electrical balance system, pressure distribution measurements were taken on the surface of the models. Holes were bored in the model, and pressure lines were carried through the support to indicating instruments. In order to accommodate the great number of measuring stations and to avoid the disturbance in the stream caused by the ordinary types of suspension, the model was split on its midplane of symmetry and held on a steel plate with a sharpened leading edge. Vibration measurements were made of the effect on the model of the jet exhaust, as well as similar measurements with three degrees of freedom and dynamic controllability. A complete representation of the shifting of the angle of attack was obtained in a single oscillogram. For greater accuracy than that afforded by the three-component measurements, a system of counterweights was installed in models, and, by using single segments of the three-component balance, direct measurements were obtained of the forces acting on the body itself. The calibration, necessary corrections, an evaluation, and the degree of accuracy of each of the measuring techniques are examined in detail.

Entwurf von Ueberschalldüsen mit Zeichnerischer Diskussion des Anfangswertproblems (Design of Supersonic Nozzles with Numerical Discussion of the Initial Value Problem). S. F. Erdmann. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F. 5,* May 20, 1948. 8 pp., 6 fold. charts. 1 reference. (In German.)

The supersonic field for a nozzle designed for 1.22 Mach is plotted on the assumption that the profile at which the local velocity of the flow is sonic is a curved surface with its peak on the axis of symmetry extending upstream to the narrowest portion of the nozzle. The velocity distribution for the same nozzle when sonic flow is confined to the narrowest part of the throat shows, instead of a constant velocity in each element of the lattice, a variation from 1.18 Mach to 1.25 Mach. By proper orientation of the flow pattern and by selection of the direction angles of the compression shocks so that they fall on the nozzle wall where it changes direction, any discontinuity in the flow along the nozzle wall can be eliminated. Complete flow patterns are given for nozzles with design Mach Numbers of 1.22, 2.14, and 3.02. The angles made by the compression waves and the nozzle wall with the centerline, in degrees, and tables for the contour of the wall and the sonic profile have been drawn up.

Numerische Behandlung des Charakteristiken-Verfahrens bei dem Entwurf von Ueberschalldüsen (Numerical Treatment of the Method of Characteristics in the Design of Supersonic Nozzles). S. F. Erdmann. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F.2,* November 15, 1948. 39 pp., figs. 4 references. (In German.)

An application of the Prandtl-Busemann method of characteristics to flows whose velocity is slightly in excess of sonic velocity. Because of the fine mesh that a diagram of the flow must have at these velocities, the customary graphical method is introduced in which the individual elements of the lattice are not determined by actual construction but are accurately and unequivocally established from the sum of the field numbers as functions of the Mach angle. An application of this method to the construction of supersonic nozzles shows that the sonic profile, the initial condition for the supersonic field, is not the narrowest section of the nozzle but a curved surface in the throat extending downstream.

The Mach Interferometer Applied to Studying an Axially Symmetric Supersonic Air Jet. John Winckler. *Review of Scientific Instruments,* Vol. 19, No. 5, May, 1948, pp. 307–322, illus., diagrs., figs. 16 references.

The method of adjustment, measurement, and evaluation of interferograms and of calculating densities in a supersonic air jet when studied with a Mach interferometer. The light source giving the best results was an unconfined air spark between vertical magnesium electrodes with a large prism monochromator. When the strongest spectral line (4481A) was used, about 200 usable fringes could be obtained on a photographic image of about $1^1/_2$ by 2 in. with an illumination time of 1 sec. The resolution, accuracy, and sensitivity of the instrument are evaluated.

Announcing a New Journal Department . . . Readers' Forum

It has been suggested by several members of the I.A.S. Editorial Committee that the *Journal* open a special department to fill the need for the more immediate communication of essential results of research in the greatly expanded and accelerated fields of the aeronautical sciences. Therefore, it has been decided to establish a new department, the "Readers' Forum," which will include letters to the editor for the quick publication of (1) brief reports of important findings in aeronautical sciences and (2) discussions of papers published in the *Journal.*

Specifications for Submission of Material

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(2) These letters should not exceed 800 words in length.

(3) Publication will be completed 6 to 8 weeks after receipt of the material.

(4) The Editorial Committee will not hold itself responsible for the opinions expressed by the correspondents, and no proofs will be sent to the authors.

(5) All letters should be double-spaced.

It is hoped that the new department may be started with the January, 1949, issue of the *Journal.* Contributions should be sent to:

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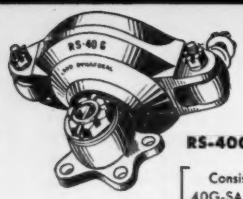

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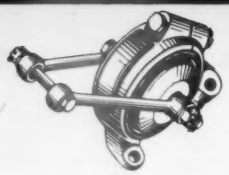

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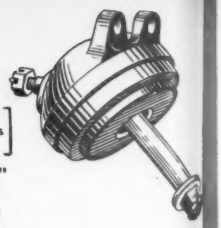

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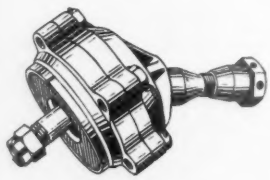

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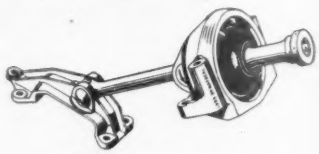

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Aeronautical Reviews

Books

Theory of Propellers

By Theodore Theodorsen. New York, McGraw-Hill Book Co., Inc., 1948. 164 pp., illus., diagrs., figs. $3.50.

In this book Dr. Theodorsen presents one of the most significant advancements in basic propeller theory since the publication, in 1929, of Dr. Sidney Goldstein's well-known paper on the optimum load distribution of lightly loaded propeller blades. Dr. Theodorsen has introduced in propeller theory a new basic parameter, called the "mass coefficient," which is an extremely useful tool in propeller analysis and design. He has also obtained the solution to an ideal dual-rotation propeller, which heretofore had not been available to the propeller designer.

In the first five chapters the fundamental aerodynamic relations for propellers having minimum induced losses without the limitation of the lightly loaded propellers, as assumed by Goldstein, are developed.

In the beginning of the book, the author describes the classical vortex theory of propellers and indicates that the thrust, torque, and efficiency are uniquely and completely established by the knowledge of the wake far behind the propeller and of the wake alone and that the classical potential flow problem of the propeller can be completely defined by the wake characteristics. In this manner the distinction between lightly and heavily loaded propellers has been eliminated. The optimum lift distribution along the propeller radius is shown to produce vortex sheets far behind the propeller which have constant pitch along their radii and which must be rigid for optimum induced efficiency.

The basic relations for the potential flow about the wake of a propeller are derived in Chapter 3. The numerical solutions as found by Goldstein, Lock and Yeatman, and Kramer have been tabulated for several advance ratios and number of blades. The usual independent parameter of propeller performance is the so-called advance ratio, V/nD. However, since the induced properties of a propeller depend on final wake configuration, the author shows that it is the V/nD of the final wake that is the proper parameter to be used for propeller analysis. The velocity in this case is the velocity of the airplane plus the final effective axial displacement velocity of the rigid helicoidal vortex system of the wake, and the diameter in this expression is the diameter of the wake rather than the propeller diameter.

The concept of the "mass coefficient," a new parameter which is used in the calculation of the thrust, torque, and efficiency of a propeller, has been introduced by the author in Chapter 4. Roughly, the mass coefficient may be visualized as simply the ratio of the cross-sectional area of a pure axial jet to that of the propeller in question, the jet having the same thrust and efficiency as the propeller. Because the propeller does not create a pure axial velocity in its wake, a frictionless propeller must be somewhat larger than a pure jet to develop the same thrust at the same induced efficiency. In Chapter 4, exact relations for the thrust, torque, and efficiency have been derived in terms of final wake displacement velocity and the mass coefficient.

In Chapter 5 the author shows that the mass coefficient may be obtained experimentally by making use of the electrical analogy of potential flow. The rigid vortex system of the propeller wake for various number of blades and advance ratios is simulated means of celluloid models having helicoidal surfaces. The difference in current flow in an electrolytic tank with and without the wake models is proportional to the mass coefficient. By using this experimental technique, the author was the first to obtain the solution to the ideal dual-rotation propeller.

Relations for the practical aerodynamic analysis and design of propellers are derived in Chapter 6. Up to this point the author has considered only the characteristics of the ideal, frictionless propeller—that is, the profile drag of the propeller sections have been neglected. The effect of profile drag is considered in this chapter, and its influence on the power coefficient and efficiency is shown in the procedure for designing a propeller for a given operating condition. Incidentally, the general procedures given in this chapter may be employed to analyze a given propeller at any operating condition. In the next chapter the author demonstrates that the slipstream contraction under normal conditions of operation is small and is of the order of about $\frac{1}{2}$ per cent of the propeller diameter.

Chapters 8 and 9 are concerned with propeller selection and body interference problems. Charts of fundamental parameters for propeller design are given in the rear of the book.

The reviewer believes that this book presents a new and stimulating approach to the whole aerodynamic theory of propellers and should be useful to aeronautical engineers specializing in the propeller field. In order to appreciate fully this work, the reader should be familiar with the past literature of the classical propeller theory.

F. B. STULEN
Chief Structures Engineer
Propeller Division
Curtiss-Wright Corporation

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Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

A Simplified Introduction to High Speed Flight

By T. F. Weldon. Osborn, Ohio, The Author, Box 227, 1948. 42 pp., diagrs. $0.75.

According to the author's own words, this booklet is an attempt to reduce some of the more salient topics of modern aerodynamics into simple, everyday English.

In 42 pages the following topics are treated:

I. The Kinetic Theory of Gases, Page 3
   1. Molecules
   2. Temperature, pressure, and density
   3. The speed of sound

II. Subsonic Aerodynamics, Page 10
   1. Relative velocities
   2. Airfoils, streamlines, and lift
   3. Drag, viscosity, and the boundary layer
   4. Compressibility effects

III. Wave Phenomena, Page 17
   1. Shock waves
   2. Expansion waves
   3. Mach waves
   4. Condensation waves

IV. Supersonic Aerodynamics, Page 27
1. The area-velocity law
2. Streamlines and lift
3. Drag
4. Sweepback

V. Transonic Aerodynamics, Page 33
1. The transonic régime
2. The five steps

VI. Thrust Units, Page 37
1. Jet propulsion
2. Air-consuming jets
3. Rockets
4. Atomic energy

The booklet seems to be a remarkably lucid survey of the whole high-speed flight story considering the obstacles encountered. For instance, one of the most common queries of the layman is, "What is a shock-wave?" This book explains the phenomenon in two or three simple paragraphs which should clear up the matter for the nontechnical public.

In fact, many of the illustrations are the standard figures found in all works on supersonic aerodynamics. The author has presented the subject matter in a manner that will do much toward increasing the understanding of those who are interested in the topic but have not had the training essential for dealing with it.

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Book Notes

AIR POWER

Report of The Chief of Staff, United States Air Force, to the Secretary of The Air Force. Washington, U.S. Govt. Printing Office, June 30, 1948. 112 pp., illus., diagrs. The rebuilding of the Air Force during the last 2 years and 8 months has followed the seven-point program stated by Gen. Carl Spaatz in 1946. The greater part of this report deals with the subjects of reorganization, scientific research, and technical development, embracing four of the points of the program. The Air-Force-in-Being, including its training and its civilian components, and industrial preparedness, embracing the other three points, complete the picture. The report is accompanied by numerous maps, organization charts, graphs, and photographs.

Air Victory: The Men and the Machines. Harold B. Hinton. New York, Harper and Bros., 1948. 428 pp., illus. $5.00. The outstanding quality of this history is the evidence of the author's intimate acquaintance with Air Force background and equipment and with its top personnel. The greater part of the book deals with the period from 1938 to 1945, but there is an introductory section that covers the period beginning with the acquisition of its first plane by the Army in 1909, to the end of 1937, and at the end a look into the future of missiles, piloted aircraft, and postwar training. For its interpretation and evaluation of events and policies the book has permanent value, aside from the detail of the record it presents.

AIRPLANE DESIGN & DESCRIPTION

Summary Report on Cross-Wind Landing Gears. John H. Geisse and Lloyd Child. Washington, U.S., Civil Aeronautics Administration, May, 1948. 17 pp., illus., diagrs. This report covers the results of the C.A.A. program of cross-wind landing gear with two personal-type airplanes: the Fairchild PT-19, using a landing gear designed by the Fairchild Engine and Airplane Corporation, and a Piper J-3, using a design by the Goodyear Aircraft Corporation. Technical details of the designs are included. It is concluded from the results of demonstrations and the reactions of 200 pilots that the cross-wind landing gear is feasible with regard to cost, and particularly with regard to safety and operating economy for personal pilots, mainly because of the possibility of smaller close-in landing areas. Later reports will cover modifications of the Ercoupe, Bellanca Cruisair, Beech AT-7, and the Douglas DC-3.

AIRPORTS & AIRWAYS

Papers Presented at the First Annual Meeting of the Airport Operators Council, April 1–3, 1948, Boston, Mass. New York, Airport Operators Council, 1948. 114 pp. $1.75. Twenty-four papers are presented on the development of nonflight revenues, airports and Federal Government agencies, gasoline storage and distribution, airports and nonscheduled and contract carriers, scheduled carriers, and ground transportation of air passengers and cargo.

ALL-WEATHER FLYING

Le Givrage (Icing). A. Viaut. Paris, Blondel la Rougéry, 1945. 57 pp., illus., diagrs. 80 fr. The formation of ice on airplanes is discussed, with western European weather in mind, from the point of view of the meteorologist. The pilot is shown how to plan flights to minimize icing dangers, and the importance of meteorological information, interpreted by the specialist, is stressed as the primary safety factor. The discussion includes the phenomenon of icing in a number of specific cases.

COMFORTIZATION

Airplane Air Conditioning Engineering Data. Part I—Properties of the Atmosphere. (S.A.E., Aeronautical Information Report No. 22.) New York, Society of Automotive Engineers, July 1, 1948. 20 pp., charts. $0.50. This is one of a series of reports prepared from data assembled to supplement Aeronautical Information Report No. 2, *Airplane Heating and Ventilating Equipment Engineering Data*, January 1, 1943. N.A.C.A. Standard Atmosphere Tables and Data, and U.S.-A.F. Summer Atmosphere Tables are included, with curves on the average moisture content of the atmosphere to 50,000 ft. and to 270,000 ft., and comparative curves of air temperature vs. altitude for cooling-system design.

ELECTRONICS

Cathode Ray Tube Displays. Edited by Theodore Soller, Merle A. Starr, and George E. Valley, Jr. (Massachusetts Institute of Technology, Radiation Laboratory Series No. 22.) New York, McGraw-Hill Book Co., Inc., 1948. 746 pp., illus., diagrs. $10. The aim of this volume is to present solutions to problems involved in the application of cathode-ray tubes to radar displays and to test equipment. Emphasis is placed on the operating characteristics of the tubes and of their auxiliary equipment and the characteristics and construction of their screens. The design of the tubes is not discussed in detail. Since the function of a radar set and the design of its display system are closely related, frequent reference is made to radar applications of cathode-ray tubes. Problems peculiar to radar are outlined, and the book progresses to the parts and functional circuits used in building up a display system and, finally, to the organization of these into complete systems.

Radar Scanners and Radomes. Edited by W. M. Cady, M. B. Karelitz, and Louis A. Turner. (Massachusetts Institute of Technology, Radiation Laboratory Series No. 26.) New York, McGraw-Hill Book Co., Inc., 1948. 491 pp., illus., diagrs. $7.00. This book is concerned with the design and operation of the antenna mount, or radar scanner, consisting of the antenna and the mechanism that causes the radiated beam to scan, which is covered in Part I and is intended primarily for the mechanical engineer. In Part II, radomes, the plastic enclosures for antennas, are discussed, with electrical considerations predominating. The book deals with equipment operating at wave lengths of 10 cm. or less and primarily with equipment developed at the M.I.T. Radiation Laboratory. In Part III, the design problem is approached by statistical methods, the principle being to minimize the root-mean-square error producing a desired result, in the presence of such disturbances as electrical noise. The relation of this technique to that discussed in Part I is explored. Footnote references are included, as well as a useful glossary.

The Fundamental Research Problems of Telecommunications. Gt. Brit., Department of Scientific and Industrial Research. London, H.M. Stationery Office, 1948. 80 pp. 1*s*.6*d*. The reports of committees on the existing state of knowledge, and their recommendations for specifically needed research in the fields of wave propagation, line propagation, vacuum-tube fundamentals, properties of materials, contact phenomena, circuitry, luminescence, photoemission, and television appraisal. Bibliographies are included on circuitry (26 items) and line propagation (65 items).

One Story of Radar. A. P. Rowe. Cambridge, Cambridge University Press; New York, The Macmillan Co., 1948. 208 pp., illus. $2.50. The purpose of this book is to give the history of the Telecommunications Research Establishment, established under the British Air Ministry and later under the Ministry of Aircraft Production, from June, 1934, to September, 1945. As a scientist, the author is exact, but his book is informal and most readable, and it is a personal, rather than an official, account. It is a valuable story of the early development of radar.

LABORATORIES, AERONAUTICAL

The Genius of Industrial Research. D. H. Killeffer. New York, Reinhold Publishing Corp., 1948. 263 pp. $4.50. The purpose of this book is to guide the young researcher to a better understanding of the nature and methods of research. The dual nature of research (pure and applied) is stated early in the book, and the two basic methods, one relying on experiments in great numbers leading to a solution and the other depending on a theory based primarily on experience, are then taken up. Designed for the individual research worker, the book does not deal with problems of management or direction but makes considerable use of actual research experiences. Most of the material is from the field of industrial chemistry.

MACHINE ELEMENTS

Mechanics of Machinery. 3rd Ed. C. W. Ham and E. J. Crane. New York, McGraw-Hill Book Co., Inc., 1948. 538 pp., diagrs. $5.00. In this new edition of a book last revised in 1938, chapters have been added on vibration and critical speeds in shafts and on gyroscopes. New material also has been added on flywheels and governors. The text has been revised but follows the same general arrangement as in previous editions. Many new problems have been added. Professor Ham is at the University of Illinois, and Mr. Crane at the Western Electric Company.

MATERIALS

Anodic Oxidation of Aluminium and Its Alloys. (A.D.A. Information Bulletin No. 14.) London, Aluminium Development Association, 1948. 61

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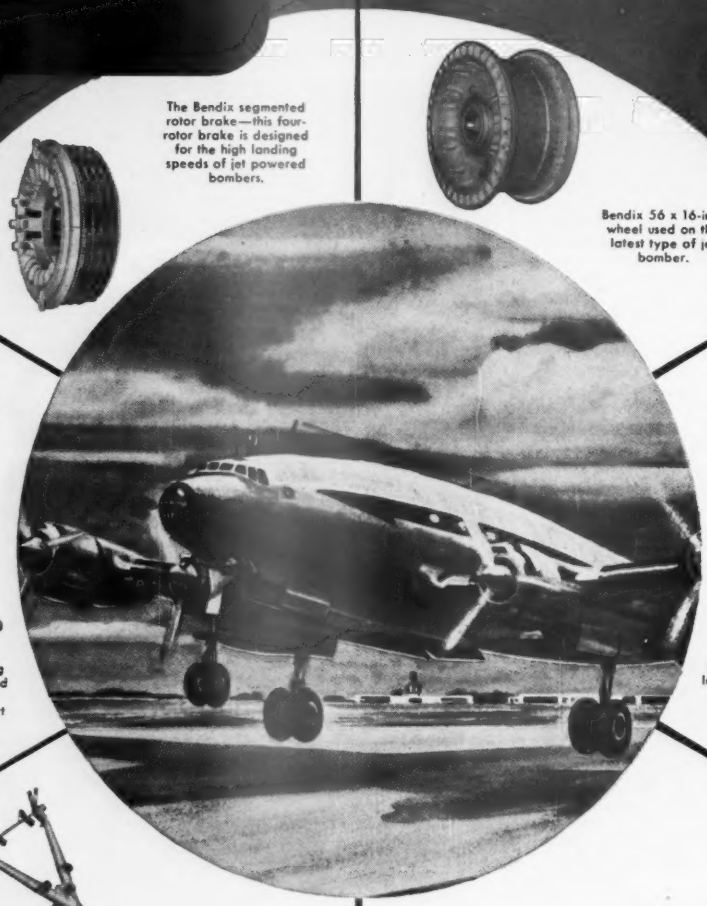

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pp., illus. 1s. The mechanism of the formation of the anodic film and processes for its formation are covered in the first part of the book and are followed by a section on dyeing of anodized aluminum. The general characteristics of the films, electrolytic brightening, and test procedures are covered in the last part. A bibliography of 40 items and an extensive list of British patents are included.

Proceedings of the First National Meeting, Forest Products Research Society, 1947. Madison 5, Wisconsin, Forest Products Research Society, 1948. 344 pp., illus., diagrs. Papers in this volume include Postwar Developments in Woodworking Glues, by Don Brouse; Metal to Wood Bonding, by Jac. H. Tigelaar; and Use of High Frequency in Woodworking, by Paul B. Zottu. The technical sessions covered the general topics of chemical utilization of wood and integrated logging, engineering aspects of wood use, and preservation and seasoning.

Tool Steel Simplified. Frank R. Palmer and George V. Luerssen. Rev. Ed. · Reading, Pa., The Carpenter Steel Co., 1948. 564 pp. illus., diagrs. $2.00. This is the first revision of a book published in 1937 and reprinted a number of times. New material has been added on the Matched Set Method, hardenability, heat-treating equipment, methods, testing, and atmosphere control and quenching. Three new chapters have been added, on the Tool Steel Selector, Time Required to Heat Tool Steel, and High Speed and Hot Work Steels.

METEOROLOGY

Study of Natural Wind and Computation of the Austausch Turbulence Constant. P. O. Huss and D. J. Portman. (Report No. 149.) Akron, Ohio, University of Akron, Daniel Guggenheim Airship Institute, January, 1948. 79 pp., illus., diagrs. This paper contains a description of the micrometeorological station set up by the Daniel Guggenheim Airship Institute in cooperation with the Office of Naval Research. The purpose of the investigation is to obtain simultaneous meteorological data at several levels of a 350-ft. tower and to study the variation of the Austausch Turbulence Constant. The various types of instruments used and their placement on the tower are discussed and the terrain surrounding the tower described. Sample records of the type to be obtained are included. An analysis is made of a section of one of the systems recorded, indicating the procedure to be followed in subsequent analyses.

Esquisse Climatographique de la Belgique (Outline of the Climatology of Belgium). L. Poucelet and H. Martin. (Institut Royal Météorologique de Belgique, Mémoires, Vol. 27.) Brussels, "L'Avenir," 1947. 265 pp., diagrs., tables, maps. Following a critical study of the data used and of climatological elements, tables are presented of data collected at various stations for the period 1901–1930. Additional data are presented in the section of maps and charts. The completeness of data varies among the stations, and the presentation separates complete from incomplete stations. About 97 stations are included. Temperature and precipitation were the data most completely recorded.

Bibliographie Météorologique Internationale. Année 1946, Fascicule IV. Paris, 196 rue de l'Université, Météorologie Nationale E.C.M. et Société Météorologique de France, 1948. 229 pp. This volume cumulates the abstracts in the four issues of 1946. It follows the Universal Decimal Classification and includes approximately 800 abstracts from articles in over 200 periodicals. Authors and titles of cross-indexed items are given under related subjects, with a reference to the classification number under which the abstract is found. An index of geographical names and an index of authors are included.

NAVIGATION

La Navigation du Pilote (Navigation for the Pilot). C. Feuvrier and E.-L. Combecal. Paris, Blondel La Rougéry, 1946. 64 pp., diagrs. Prepared as a practical manual for the solo pilot, this book presents systematically the procedures in planning a flight, the coordination of the flight plan with actual flight conditions, and methods of orientation during low-altitude day and night flying, with or without the use of radio aids. A chapter is included on the functions of the copilot.

OPERATIONS

Proceedings, National Aviation Clinic, October, 1946. Oklahoma City, Okla., Harlow Publishing Corp., 1947. 396 pp., illus. $3.00. Topics and speakers at the sessions were: "Air Transportation," Robert S. Henry, Robert Ramspeck, and H. Struve Hensel; "Aviation Manufacturing Industry," Frank Clark, William T. Piper, Lawrence D. Bell, Reginald E. Gillmor, and Robert S. Fogg; "Private Flying," N. R. Hanson, J. B. Hartrauft, Jr., Max Karant, Jerome Lederer, and Forrest E. Watson; "Airports," Arthur I. Boreman, John H. Hoffman, T. P. Wright, and Joseph McGoldrick; "Utilization of Aviation Services and Products," Robert W. Jackson, Ralph D. Paine, Jr., Elizabeth Gordon, John Paul Jones, and John F. Victory; "Aviation Short Courses," James H. Doolittle, and the Rev. John J. Cavanaugh.

ORDNANCE & ARMAMENT

Rockets, Guns and Targets. Edited by John E. Burchard. Boston, Little, Brown and Co., 1948. 482 pp. $6.00. This detailed history covers the work of Divisions 1, 2, and 3 of the National Defense Research Committee under the Office of Scientific Research and Development. Almost half of the book deals with the work of Division 3, on Rocket Ordnance, including aircraft rockets and jet-assisted take-off for aircraft. Part 2 is concerned with Terminal Ballistics, covering the work of Division 2 on the effects produced by weapons through impact and explosion. Part 3 deals with investigations in the field of gun design, including hypervelocity guns and control of gun erosion. The various chapters were written by persons connected with the work described under the direction of the division chiefs. The nature of the various problems requiring solution, as well as their solutions, is described in nontechnical language. The administrative history is covered in considerable detail. This is one of a series of volumes on the history of the Office of Scientific Research and Development, which is issued under the title of *Science in World War II*.

PHOTOGRAPHY

Aerial Photographs in Forestry. Stephen H. Spurr. New York, The Ronald Press Company, 1948. 340 pp., illus., diagrs. $6.00. The aim of this book is to bring together the existing information on the use of photographs in forest mapping, inventory, road and railroad location, and other phases of forest management. The first two parts deal with Aerial Photographs and Aerial Surveying, covering those aspects of photogrammetry applicable to forestry. The third and fourth parts on Photo-Interpretation and Forestry Applications contain the results of research at the Harvard Forest, much of which has not previously been published. About 250 references are given at the ends of chapters.

POWER PLANTS

The Theory and Practice of Heat Engines; Including Steam Generators, Reciprocating Steam Engines, Steam Turbines, and Internal Combustion Engines. R. H. Grundy. London, New York, Longmans, Green and Co., 1947. 723 pp., illus., diagrs. $6.00. This is the fifth reprinting of book first published in 1942. Theory and practice are covered in separate parts but are intended to be read together. The book is intended for engineering students as a preparation for more specialized study. The more advanced sections are so designed that they can be omitted at a first reading. A bibliography of selected books is included.

Design Features for Automatic Engine Power Controls. (S.A.E., Aeronautical Information Report No. 10.) New York, Society of Automotive Engineers, September 1, 1944. 25 pp., diagrs., charts. $0.50. This report, recently declassified, covers suggested design requirements for the following automatic power control elements: intake manifold-pressure or torque regulator; engine-speed coordinator; supercharger-speed coordinator; spark-advance coordinator; and mixture-strength coordinator.

Rotary Valve Engines. Marcus C. Inman Hunter. New York, John Wiley & Sons, Inc., 1948. 216 pp., illus., diagrs. $5.00. (*See* AER 11/47:55.) The American edition of the first book, devoted entirely to the principles and design of rotary valve engines, published in London in 1947.

PRODUCTION

Aircraft Development and Production. Edited by M. M. Williamson and G. W. Williamson. London, Paul Elek Publishers, Ltd., 1948. 314 pp., illus., diagrs. 30*s*. This is the first postwar edition of this yearbook, formerly published as the *Aeroplane Production Year Book and Manual*. The greater part of the book consists of descriptions of aircraft, engines, and equipment of the postwar period, including engine accessories, landing gears, hydraulic equipment, electrical equipment, instruments, cabin superchargers and air conditioning, and some ground equipment. The descriptions of equipment are generally detailed and well illustrated, and those of aircraft and engines are less detailed. The following articles on future transport aircraft are included: "Design and Construction," by H. Roxbee Cox; "British Aircraft for Empire Services," by E. Colston Shepherd; and "Modern Air Travel," by E. B. Methven. Articles on new applications of aircraft materials are: "Centrifugal Castings in High Tensile Alloy Steel," by J. F. B. Jackson; "Asbestos in Aircraft," by J. E. Heald; and "Plywood Engineering," by Arthur Scroggs.

SCIENCES, GENERAL

CHEMISTRY

Chemistry; A History of the Chemistry Components of the National Defense Research Committee, 1940–1946. Edited by W. A. Noyes, Jr. Boston, Little, Brown and Co., 1948. 524 pp. $6.00. This volume in the series on "Science in World War II" covers the work of the following Divisions of the National Defense Research Committee: Division 8, Explosives; Division 9, Chemistry; Division 10, Absorbents and Aerosols; Division 11, Chemical Engineering; and Division 19, Miscellaneous Weapons (principally weapons for sabotage). The work of the Tropical Deterioration Committee is also included. The research described includes work on hydraulic fluids, oxygen and oxygen equipment, protection of fuel tanks, special fuels, and detonation and shock waves.

MATHEMATICS

Analytic Geometry. Roscoe Woods. Rev. Ed. New York, The Macmillan Company, 1948. 322 pp., diagrs. $4.50. In this revised edition of a book first published in 1939, the original plan is unchanged, but the exercises have been revised and rearranged throughout and new exercises have been added. The book is designed for use in introductory courses in analytic geometry. The part containing the introductory phase has been revised to some extent. The last half of the book deals with simple geometric properties and constructions of conics, the second degree equation in rectangular coordinates, and, in the final three chapters, solid analytic geometry. The author is a professor at the State University of Iowa.

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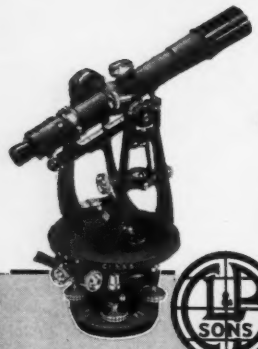

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Tables of the Bessel Functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leq X \leq 1$. (U.S., National Bureau of Standards, Applied Mathematics Series No. 1.) Washington, U.S. Govt. Printing Office, 1948. 60 pp. $0.35. These tables were compiled to avoid the necessity of interpolating in existing tables, which are inaccurate in the range of small arguments, in calculating the properties of rod lattice systems and control rods in chain reacting piles and units. They should be useful in other engineering and design problems.

PHYSICS

Applied Physics; Electronics, Optics, Metallurgy. Boston, Little, Brown and Co., 1948. 456 pp., illus. $6.00. This volume in the series on "Science in World War II" covers the work of the following divisions of the National Defense Research Committee: Division 13, Electrical Communication; Division 16, Optics; Division 17, Physics; and Division 18, Metallurgy. Research problems solved by these divisions included work in the fields of direction finding, radio propagation, very-high-frequency transmission, aerial cameras, camouflage problems, telemetering equipment and strain gages for aircraft, propagation, measurement and control of sound waves, heat-resistant alloys, and materials for aircraft construction.

STRESS ANALYSIS & STRUCTURES

Statik för Flygplanskal (Stress Distribution in Aeroplane Shell Constructions). Thorkild Rand. Linköping, Saab Aircraft Company, 1948. 201 pp., illus., diagrs. Theories for the calculation of stress distribution in shells are reviewed in the first half of this dissertation, with special consideration of flat or slightly curved shells. The cylindrical shell, with and without holes, is considered in Chapter 2. In Chapter 3, panels are considered as a statically indeterminate system, the units of which act in the manner assumed in the shear field theory. In Chapter 4, a method is developed for the calculation of stresses in panels using integral equations that can be solved for any given conditions of elasticity in a panel by a trial-and-error method. In Chapter 5, an electrical analogy method is developed which is capable of solutions in considerably less time. These theories are applied in the second half of the dissertation to a pressure side panel in the wing of a Saab airplane. The method of Chapter 4 occupied eight men for 8 weeks, while the electrical analogy method took the time of one man for $1^1/_2$ weeks. The panel was considered as two systems, one an ideal system statically indeterminate to the 29th degree and the other to the 35th degree, where the conditions of deformation are increased so that the angular deformations are equal to zero for one stringer. The differences between the long and short methods were approximately 2 to 3 per cent for the statically indeterminate system of the 35th degree and about 4 per cent for the system of the 29th degree. A bibliography of 37 items is included, as well as an English summary of 5 pages.

Propeller Considerations for High-Speed Aircraft

(*Continued from page 35*)

detail, other than to mention a few of the more important conclusions.

In general, these studies indicate that for a maximum cruising altitude of 35,000 ft. turboprop-powered aircraft will have a greater maximum range than turbojet-powered aircraft at speeds up to at least 600 m.p.h. For this same maximum cruising altitude, aircraft designed for maximum ranges of more than 3,000 to 3,500 miles will have the highest average top speed when powered with turboprop or reciprocating engines.

This would appear to require the application of the turbojet engine to the high-speed, high-altitude aircraft with relatively short range. However, studies based on power plants with equivalent fuel consumption indicate that the overall performance of a propeller-driven airplane can be substantially superior to the turbojet, even in this category. In order to be conservative in these particular studies, the gross weight and drag of the propeller-driven airplane were assumed to be greater than the jet-propelled airplane. In addition, propeller efficiencies were assumed which were substantially less than those obtained during the tests previously discussed in this paper. For the same maximum speed for both airplanes, the propeller-driven airplane, despite its higher weight, had a better rate of climb. In addition, its take-off run was approximately one-half that of the jet-powered airplane without JATO assistance.

Of course, it might be argued that probable future improvements in fuel economy or momentary power increases of turbojets will change the picture considerably. However, it is obvious that any such improvements in efficiency of the turbojet will be equally applicable to the propeller turbine and, therefore, the same relative positions should be maintained. It may be concluded, therefore, that the turbine-jet power plant will be favored over the propeller turbine, only on aircraft of relatively limited range, where extremely high-speed and high-altitude performance is required at the sacrifice of fuel economy.

In this brief summary, it is obviously impossible to more than scratch the surface of the many problems associated with high-speed propellers and their controls. It is hoped, however, that this discussion has helped to define some of the associated factors involved which have been under continued research, development, and investigation by propeller designers for the past several years. The results of testing to date are already being incorporated in propellers of greatly improved design; and, with our continued development toward the solution of all these problems, we feel confident that the propeller has a bright and lasting future.

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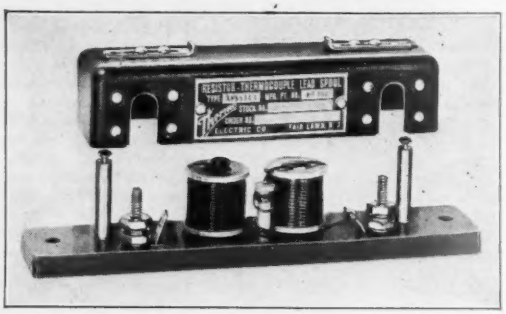

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(*Continued from page 14*)

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Jarck, Berneice Helen, A.B., Assoc. Editor, JOURNAL OF THE AERONAUTICAL SCIENCES, AERONAUTICAL ENGINEERING REVIEW, and AERONAUTICAL ENGINEERING CATALOG, Institute of the Aeronautical Sciences, Inc.

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Elected to Technical Member Grade

Arment, Donald E., Electronic Technician, Special Measurements Unit, Aircraft Lab., Hqs., A.M.C. (Wright-Patterson Air Force Base).

Baker, Samuel Keith, Senior Test Engineer, Power Plant Design, The Glenn L. Martin Co.

Bloom, Martin, B.M.E., Research Asst., Dept. of Aeronautics & Applied Mechanics, Polytechnic Institute of Brooklyn.

Cody, Joseph Bernard, B. of A.E., Instructor of Aero. Subjects, The Catholic University of America.

Milani, Walter J., Aero. Research Asst., New York University.

Romano, Frank Jerry, B.M.E., Research Asst., Polytechnic Institute of Brooklyn.

Shames, Harold, B.M.E., Aero. Research Scientist, Flight Propulsion Research Lab., N.A.C.A.

Transferred to Technical Member Grade

Adair, Glenn Howard, M.E. (Aero), Engineer, Langley Mem. Aero Lab., N.A.C.A.

Altman, John Martin, B.S.Ae., Engineer P-1, Ames Aero. Lab., N.A.C.A.

Baldwin, Louis Beardslee, Jr., B.S., Student, Massachusetts Institute of Technology.

Baxter, John W., B.S. in M.E. (Aero.), Engineer, Alexander Shipyard, Inc.

Berger, Howard M., B.S.E. (Aero.), Research Asst., California Institute of Technology.

Bray, Raymond Harris, M.Ae.E., Engineering Officer, R.C.A.F.

Breaux, Gerald Paul, B.S., Graduate Student, California Institute of Technology.

Brunale, Vito John, Design Draftsman, Porthman Machine Tool Co.

Burbank, Paige Belden, B.S., Graduate Research Asst., University of Illinois.

Burnham, Robert Wallace, B.Sc., Detail Engineer, Boeing Airplane Co.

Butti, Bruno, Engineer, Goodyear Aircraft Corp.

Carbee, Robert Mitchell, S.B., Aero. Engineer, Grumman Aircraft Engineering Corp.

Church, James D., B.S. in Ae.E., Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Ciezak, Theodore James, B.S. in Ae.E., Jr. Engineer, Design Section, Fredric Flader, Inc.

Coffman, William Buchanan, B.S., Stress Analyst, Curtiss-Wright Corp.

Colarusso, Paul E., Ae.E., Engineering Aide, Flight Propulsion Lab., Wind Tunnel & Flight Section, N.A.C.A.

Cutler, Marvin Michael, B.Ae.E.

Drozd, Joseph W., B.S.

Dumont, Lincoln Balon, B.A.Sc., Aero. Engineer on Steam Turbines, General Electric Co.

Earp, Lester E., B.S. in Ae.E., Flight Test Engineer, Chance Vought Aircraft.

Eatock, Henry Clare, B.A.Sc., Jr. Aerodynamicist & Performance Engineer, A. V. Roe Canada, Ltd.

Eckber, Donald P., B.S. in Ae.E., Jr. Engineer, Packard Motor Car Co.

Ellison, Donald W., B.S. in Ae.E., Stress Analyst, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Ferdman, Saul, Ae.E., Aero. Engineer P-1, Langley Mem. Aero. Lab., N.A.C.A.

Friedman, Morton Benjamin, B.Ae.E., Jr. Engineer, Cornell Aero. Lab.

Gault, Earl Warren, B.S. in Ae.E., Jr. Engineer, Airplane Div., Curtiss-Wright Corp.

Grogan, George Calvin, Jr., M.S. in ME., Aerodynamicist "B," Consolidated Vultee Aircraft Corp.

Grossman, Eli, B.Ae.E., Jr. Stress Analyst, The Glenn L. Martin Co.

Gruenberg, Charles L., A.A. in Ae.E., Student, Oklahoma University.

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Jarrett, Henry Waverly, Jr., B.S. in Ae.E., Structural Engineer, Curtiss-Wright Corp. (Columbus Plant).

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Marx, Howard Flemin, S.M. in Ae.E., Aerodynamicist "B," Consolidated Vultee Aircraft Corp.

Massaia, Edward Joseph, Engineer's Asst., Flakice Corp.

McCallister, Paul R., A.A. in Ae.E., Technical Illustrator, Jr., McDonnell Aircraft Corp.

McCoy, Kenneth L., B.S., Graduate Student of Ae.E., Cornell University.

McNicoll, Andrew M., B.Ae.E.

Miller, Edward S., B.Ae.E., Jr. Aerodynamic Engineer, Flight Test Section, Chase Aircraft Co., Inc.

Mollenberg, Ernst Fritz, B.Ae.E., Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Morgan, Harold Victor, S.B., Jr. Vibration Engineer, The Glenn L. Martin Co.

Nelson, Donald H., Jr., B.S., Student, Massachusetts Institute of Technology.

Newman, Carl S., S.B. & S.M., Asst. Aero. Engineer, Cornell Aero. Lab.

Noel, Robert G., B. of Ae.E., Jr. Design Engineer, NEPA Div., Fairchild Engine & Airplane Corp.

Oliver, Robert Norris, B.S., Research Engineer, Douglas Aircraft Co., Inc.

Parsons, Earl Robert, Jr., B.S., Weights Estimator, Boeing Airplane Co. (Wichita).

Petersen, Charles Arthur, B.S., Design Engineer, Airplane Div., Curtiss-Wright Corp.

Pierce, William Robert, B.S., in Ae.E., Aero. Engineer, Boeing Airplane Co.

Pon, Daisy, Miss, B.A. Sc., Aerodynamicist, A. V. Roe Canada, Ltd.

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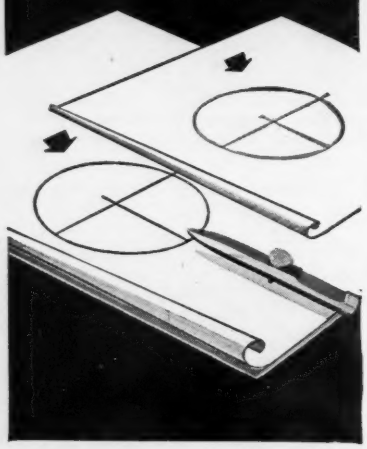

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White, Laurin C., B.S. in M.E. (Aero.), Research Lab. Analyst; Consolidated Vultee Aircraft Corp.

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Wismann, Harold Francis, B.S., Graduate Student, Indiana University.

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Personnel Opportunities

This Section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aircraft Engineers—Opportunities for research and development on the B-36, world's largest bomber, and other heavy aircraft, at Convair's Fort Worth, Tex., Division. Experienced engineers needed now in these classifications: Aerodynamicists, Engineering Designers, and Engineering Draftsmen. Send complete summary of training and experience to Engineering Personnel Office, Consolidated Vultee Aircraft Corporation, Fort Worth, Tex.

Structural Designers—Engineers experienced in design of sheet-metal structures desired for large cargo aircraft project. Graduate engineers preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Layout Draftsmen—Six or more years' experience in aircraft layout and design. Cargo aircraft experience desired. Graduate engineers preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Stress Analysts—Personnel with experience on sheet-metal, monocoque, cargo-type aircraft desired. Graduate engineers with 5 or more years' experience preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Research Aeronautical Engineer—Engineering graduate with good command of physics and mathematics, to assist in the conduct of ballistic research. Excellent opportunity to obtain research experience and advanced degree. Address reply to D. W. Dutton, Director, Daniel Guggenheim School of Aeronautics, Georgia Institute of Technology, Atlanta, Ga., giving full particulars. Salary open.

Engineers—Rotary Wing—Now engaged in C.A.A. certification. Unlimited opportunities for qualified stress analyst, flight-test engineer, detail and layout draftsmen. Opening as Chief Engineer to take charge of certification work. Write full particulars to Jensen Helicopter Company, Inc., Tonasket, Wash.

Aeronautical Engineer—A position is available in the Research and Development Group of the Naval Bureau of Aeronautics in Washington, D.C., for an Aeronautical Engineer preferably with a background in electronics. Duties will involve research and development program planning and related tasks of justification presentation and analysis. Ability to express complex thought in clear readable fashion essential. This position is under Civil Service and will command a salary of $6,235 per annum. Address: Personnel Division, Bureau of Aeronautics, Department of the Navy, Washington, D.C.

Aeronautical Engineers—The U.S. Naval Air Station, Quonset Point, R.I., has announced a probational examination for Aeronautical Engineer (Power Plants) $4,479 a year, and Aeronautical Engineer (General) $4,479 to $7,432 a year. This examination will be used to fill future vacancies occurring at the Air Station and at other Federal Agencies throughout the New England states. Applications are being accepted until further notice. Write to Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I., for further details.

Flutter Engineer—Aeronautical Engineering graduate with several years of experience in flutter and vibration problems for work on advanced military aircraft. Address reply to Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles, Calif.

Preliminary Design Engineer—The Agricultural and Mechanical College of Texas, Department of Aeronautical Engineering, has an opening for a man to teach preliminary design and participate in aeronautical research. Facilities include large wind tunnel, excellent paved airport, and flight-research equipment. Rank and salary dependent on training and experience of applicant. Edward E. Brush, Department of Aeronautical Engineering, A. & M. College of Texas, College Station, Tex.

Jet Engine Specialists, Aerodynamicists, and Thermodynamicists—Needed for research and development work on supersonic ram-jet engine projects. Experienced men needed also for development work on electrical, mechanical, and pneumatic control systems—accessory and fuel. Good openings available at present because of large-scale expansion program. Write to, or apply at, Marquardt Aircraft Company, 4221 S. Lincoln Blvd., Venice, Calif.

Engineers and Scientists—The Navy Department is seeking engineers and scientists in practically every field for employment in Washington, D.C. Specific vacancies exist for aeronautical, civil, electrical, electronics, industrial, marine, and mechanical engineers, and for mathematicians, Naval architects, physicists, and others, with salaries ranging from $2,974.80 to $10,330. Some of the positions involve occasional travel to Naval Shore Establishments for the purpose of observing or participating in scientific tests of Naval equipment. Others require original research or planning scientific programs. All of the positions are concerned with the most recent advancements in the scientific field. Applications for the positions should be made on Standard Form 57, available at any first- or second-class Post Office, and should be mailed to Code 612, Room 1213, Main Navy Bldg., 17th and Constitution Ave., Washington, D.C.

Electrical and Aeronautical Engineers—Corporation engaged in development of aircraft remote control and telemetering equipment has need for engineers of several categories: (1) Young graduate electrical engineers having good background in electronics and communications. (2) Graduate electrical engineers with experience in electronics and communications. (3) Graduate electrical or mechanical engineers having background in servomechanism design. (4) Aeronautical engineers having experience in stability and control. Wing Engineering Corporation, Colonial Bldg., Philadelphia 7, Pa.

Research Personnel—Employment opportunities are for engineering graduates interested in subsonic or supersonic aerodynamic testing and research. Employees desiring to undertake graduate study can arrange their working hours accordingly. Write to Department of Aeronautical Engineering, University of Washington, Seattle 5, Wash.

Instructors—One opening for an aeronautical engineering graduate with industrial experience appropriate for teaching stress analysis and aircraft structures. Other openings are available for engineering graduates who will teach engineering drawing and engineering mechanics. Part-time employment permitting intensive graduate study can be substituted if applicant wishes to obtain an advanced degree. Write to Department of Aeronautical Engineering, University of Washington, Seattle 5, Wash.

Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical or experimental background to engage in development of facilities and model test work in stability, control, high-speed, and supersonic aerodynamics. Projects include new models of piloted and pilotless aircraft, new wind tunnels and associated equipment, and advanced testing techniques. Salary in accordance with qualifications and Civil Service regulations. In reply, please give summary of personal qualifications, education, and experience. Address—Director, David Taylor Model Basin, Washington 7, D.C.

907. Engineering Administrator—For instrument development laboratory in New York Metropolitan area. Experience on design, development, and manufacture of aircraft instruments, telemetering equipment, and servomechanisms desirable. Own engineering talent less important than ability to organize and direct others. Salary: $6,000 to $10,000.

895. Research Scientists—Experienced research scientists with advanced degrees and experience in applied physics, aerodynamics, thermodynamics, mathematics, or chemistry to perform supervisory research and act as permanent consulting group to engineering laboratory. Excellent opportunity for men with right qualifications. Salary, $8,000–$14,000 bracket.

893. Engineers—West Coast airplane manufacturer has need for additional aerodynamicists, stress analysts, and airplane control system designers having experience with servomechanisms and automatic pilots.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

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913. Engineer—B.M.E. Graduate studies in mathematics and engineering. One year as assistant project engineer on automatic aircraft control. Two years in analysis of the dynamics

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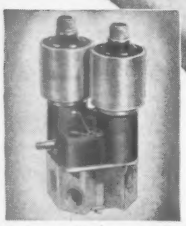

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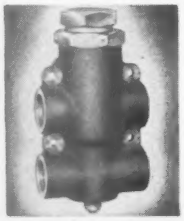

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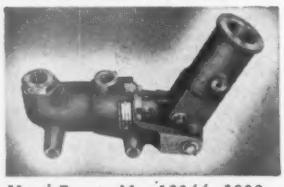

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906. Management or Engineering—B.S. in A.E. Ten years' experience including teaching, aircraft stress analysis, and aircraft propellers. Six of these years as Assistant Chief Engineer and Chief Engineer in propellers. Will accept position in other fields as well as aircraft.

904. Aeronautical Engineer—M.S. in Ae.E' Five years' experience in field of aeroelasticity.

903. Public Relations Representative—Seven years' experience in the active promotion of aircraft and propellers by teaching; lecturing societies, industrial, and civic groups; preparing publicity programs and press releases and over 40 technical and trade articles and papers. Writer—Editor of 1947 First Award Winning Paper of Lincoln Arc Welding Foundation contest. Foreign experience (Europe) representing U.S. aircraft manufacturer. Member U.S. T.I.I.C. team which explored German industry and returned latest developments to this country. Experienced in conducting plant tours, trade displays, civic, educational, press relations, and advertising agency liaison. Has had charge of entire program to introduce a unique mechanical product, educate the sales organization, and inform the trade and public. Desires position with manufacturer making finished mechanical prod-

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900. Aeronautical Engineer—Age 36; married. Two and one-half years with major aircraft manufacturers as a specialist in weights and balance, technical writing, technical reports, and specifications writing. Able to handle and familiar with machine-shop practice. Holds a valid A. & E. license from the C.A.A. Has had approximately 12 years' all-around experience on transport and private-type aircraft as a technician. Would like position as technical reports writer, liaison, and/or maintenance engineer.

899. Engineer—Housing requires a change of position this fall. Associate Professor, Aeronautical Engineering; age 32; large mid-western university. Technical Director of sponsored powerplant research project. Industry or university position considered. Rental housing for family of five a necessity.

898. Engineer—B. Aero. E., M. Aero. E. Three and one-half years' industrial experience, including over 2 years' aerodynamics in wind tunnel, performance, air loads, stability, and control. Past 1½ years as experimental research engineer with East Coast precision instrument corporation. Duties included design and operation of experimental equipment. Graduate studies include aerodynamics, both theoretical and applied, aviation gas turbines, stress analysis, dynamics of aircraft. Would prefer teaching position in New York area but will travel if necessary.

897. Associate Professor—Ph.D. in Applied Mechanics, degree in Aeronautical and Mechanical Engineering. Five years' experience in industry and research; head of structures department with aircraft manufacturer. Wishes to obtain university position teaching theoretical graduate courses in applied mechanics or mathematics, with opportunities for research.

896. Industrial Engineer—Three years' aircraft development and manufacturing experience. B.S. in Ae.E., M.S. in Industrial Engineering (June, 1948). Immediately available.

892. Engineer—B.A.E., 1946. Age 22; married. Two years' experience as project engineer engaged in research, development, and testing at a large wind-tunnel establishment. Experienced in organizing and directing projects; analyzing wind-tunnel data and writing technical reports; dealing with people such as representatives of government bureaus and contracting companies. Interested in permanent position in business associated with aircraft sales. Open to any interesting offer affording possibilities for good future. Eastern U.S. location preferred.

891. Professor—Professor of Aeronautical Engineering desires change to position in more favorable climate. Industrial experience as chief aerodynamicist. Papers on dynamics and thermodynamics. Advanced degree.

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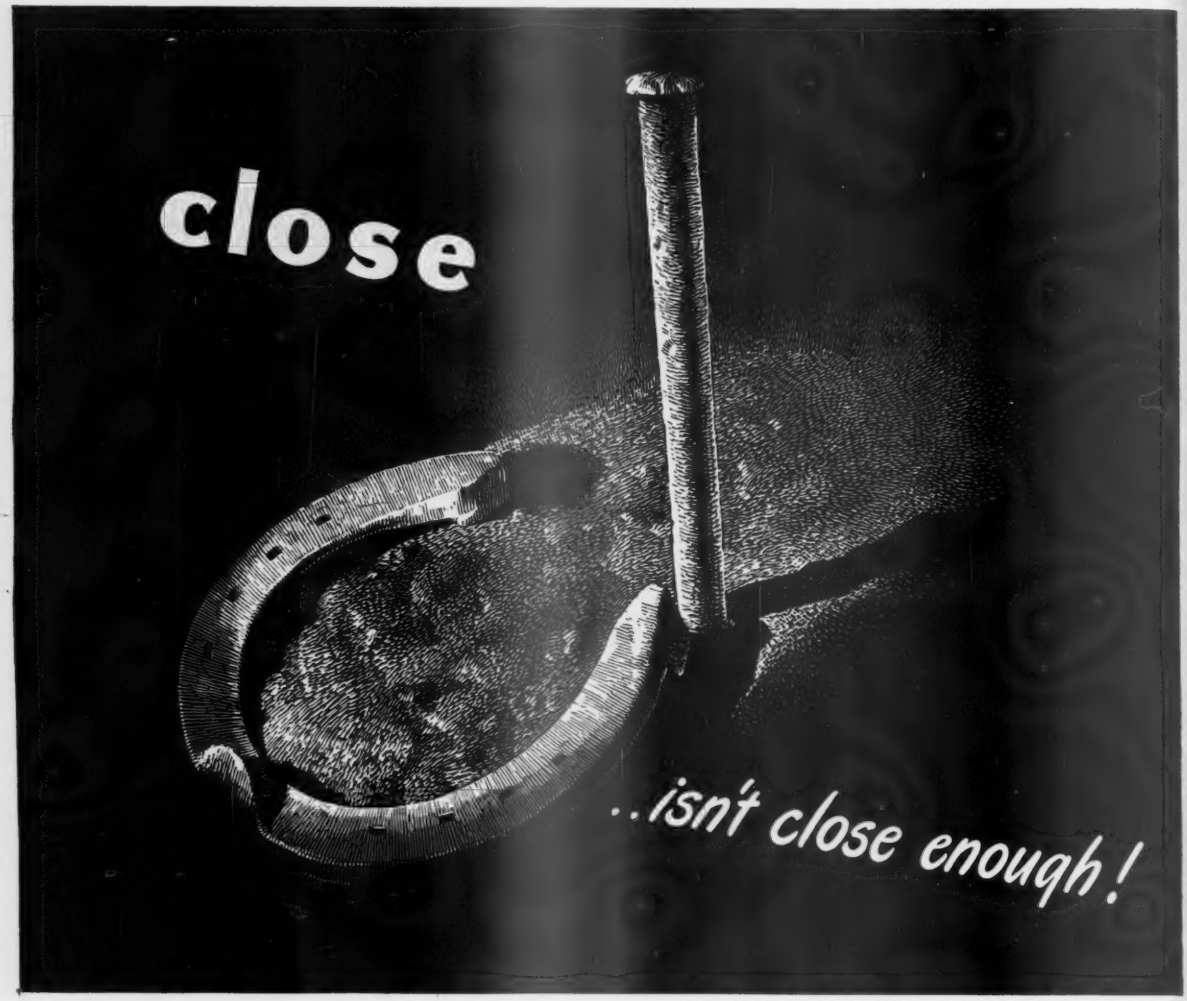

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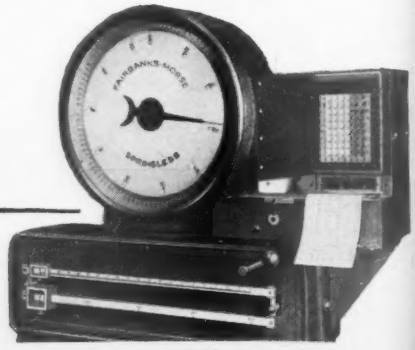

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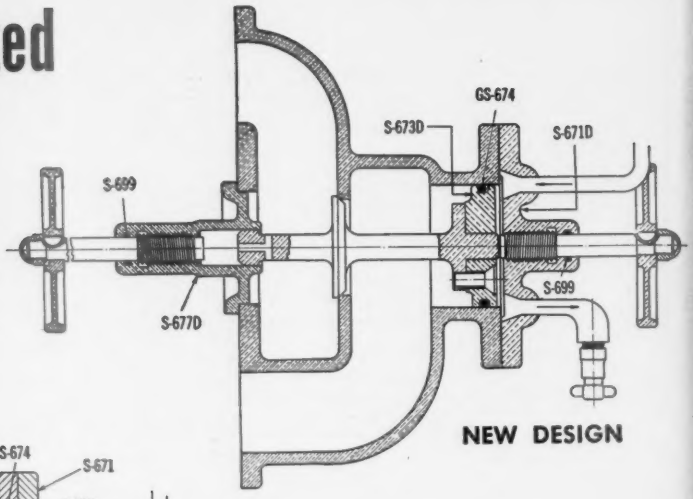

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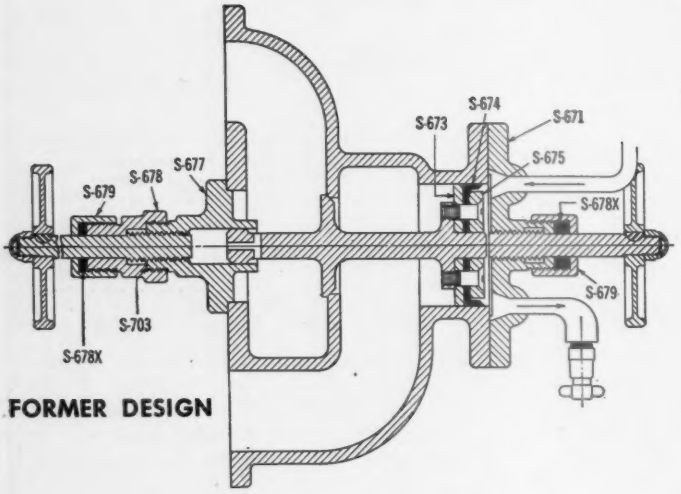

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